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Eskola, Elina

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Elina Eskola

Studiestræde 6, DK-1455 Copenhagen K., Denmark
Tel. +45 35 32 30 82 - Fax +45 35 32 30 00
http://www.econ.ku.dk

Improving Trade and Transport Services in Tanzania: A General Equilibrium Approach

ELINA ESKOLA[12]

Abstract:

The study uses a computable general equilibrium (CGE) approach to simulate the welfare gains of improving trade and transport services in Tanzania up to the year 2015. The model takes into account the regional differences in trading margins and the different production patterns of commercial and subsistence producers. The results show that substantial economic growth can be achieved by alleviating the existing bottle necks in marketing. The regional growth patterns of production after market improvement favour the more isolated and often poorer regions, leading to decreased regional inequality over time. The main beneficiaries of the policy change are the rural poor whose income grows faster than the income of the wealthier urban dwellers. The results suggest, that if sufficient resources and political commitment to improving trade and transport sectors can be mobilised, the economic performance can be enhanced to reach the Millennium Development Goals by 2015.

Keywords:
Computable General Equilibrium (CGE), regional growth, commercialisation, infrastructure, trade, pro-poor growth, Tanzania, Millennium Development Goals.

JEL classification: C68, D58, F14, I38, O55

[1] University of Sussex, currently visiting the University of Copenhagen. Address for correspondence: Elina.Eskola@econ.ku.dk, Studiestraede 6, DK-1455 Copenhagen, Denmark.

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1. Introduction

Marketing margins in Sub-Saharan countries are large compared to other continents (Delgado *et al.* 1995, Limao & Venables 2001). The agricultural sector, which is often the dominating sector in poor countries, is hit the hardest by large costs of marketing due to bulky transportation and cumbersome supply chains. The high trading margins affect the price of food, reduce the area in which it is marketed, favour the use of imported food, and limit food export possibilities (Minten & Kyle 1999). Also Tanzania's economy is heavily dependent on agricultural production that account to roughly half of the country's GDP. The focus of the discussion on the agricultural sector as a source of wealth and livelihood has traditionally been on production. However, in recent years looking at agricultural marketing has gained more ground in the debate as farmers have failed to sell their crops or the prices paid have been lower than expected. In order to address the problems with agricultural marketing, the government of Tanzania is currently formulating a new Agricultural Marketing Policy (AMP), which is aimed at addressing problems in agricultural trade and facilitating the use of agricultural marketing as a means to enhance economic growth.

Easier access to markets and lower transaction costs would clearly be a desirable policy objective as it would mean lower dead weight loss to the society from unrealised trade, higher farm gate prices and/or lower consumer prices, greater supply and variety of goods at the market, new opportunities for producers and manual labour, as well as possible changes in overall prices and wages due to changed equilibrium conditions at the market. The importance of active trade facilitation has become an actively discussed topic also in the Tanzanian political debate, and the government has already taken political decisions in order to facilitate trade. Tanzania has carried out a substantial programme of trade liberalisation that started in the 1980's and by 1990 virtually all restrictions on the private trade in grains had been removed. During this time Tanzania has undergone a large-scale renewal of macro policies to enhance the trading environment and the government has streamlined the legal framework to encourage trade and investment. However, the effect of the formal liberalisation has not led to the desired realisation of the growth potential due to, among other things, remaining barriers for trade. The current level of physical infrastructure is insufficient to support efficient trade in the country, and cumbersome trading arrangements and long supply chains work as effective market barriers. In order to combat the existing impediments for trade, the government of Tanzania has designed new development programmes aimed at lowering the cost of trade. The most notable programme to enhance hard infrastructure is the Road Sector Development Programme, and the largest plan to strengthen the trading culture is a joint effort of Tanzanian authorities and the donors, so-called Business Environment Strengthening for Tanzania (BEST).

However, despite the benevolent plans of improvement, the road construction is currently lagging behind due to insufficient funding for its implementation, and the private sector renewal is slowed down by the weak implementation of readily written policies, unhurried preparation of tools to enforce the existing laws, and sluggishly changing business environment largely based on personal contacts. The lack of commitment to the change might be due to the fact that very little is in fact known about the true benefits of investing in infrastructure and facilitating trade at national level. Such policies are likely to lead to increased welfare but how large the impact will be, how the benefits are distributed, and what sectoral and regional changes they would imply is still not well understood. The aim of the current study is to contribute to the existing discussion by analysing the likely impact of enhancing the trading environment in Tanzania, and by measuring the possible gains and distributional effects that such policies would imply.

1.1 Marketing Margins and Economic Growth

Two interlinked factors determine the marketing margin: transportation costs and transaction costs. In a cross-country context transportation margins have been portrayed as the curse of especially Sub-Saharan Africa, where the marketing margins impose an additional barrier for trade and introduce an informal tax for domestic producers (Kweka 2004). Especially for land locked countries, the transportation costs can become a major part of the selling price (Delgado *et al.* 1995) and Limao & Venables (2001) argue that the relatively low level of African trade flows is largely due to poor infrastructure. Adequate infrastructure has been promoted in the literature as a necessary pre-requisite for efficient trading (e.g. Ndumbaro 1995, Larson & Deininger 2001), as well as a source of increased economic activity and growth (Fan *et al.* 2000a, 2000b 2005a). As outlined by Fan (2005a), the earlier studies on roads and growth have investigated the impact of infrastructure as a direct factor in the production function, and concluded that there is a strong positive relation between the level of infrastructure and aggregate productivity (see e.g. Antle 1983, Biswanger *et al*. 1987). From these studies, however, it is still unclear whether the link between infrastructure and growth works so that enhanced infrastructure creates better economic environment, or if it implies a reversed causality so that faster growing economies invest more in roads. Fernald (1999) has explicitly investigated the question of causality and its direction using time-series data for the US. In his study Fernald shows that road construction precedes and seems to lead to higher growth, even though he argues that the roads lead only to a one-time non-repeatable growth boost. Fan *et al.* (2000b, 2004) have also addressed the problem of possible reversed causality by using a system of equations, and concluded that road investment is important for promoting growth and poverty reduction.

Besides increased level of growth, improved infrastructure has also been linked directly to poverty alleviation. Jacoby (2001) found that improved road access to markets would generate substantial total benefits through better profitability and improved trade, and a large share of the benefits would be captured by poor households. Also Escobal (2001) found in his study on rural Peru that access to roads raised the profitability of both farm and non-farm activities, and allowed the poor households to diversify their income sources. Increased income earning opportunities in the rural areas have a direct impact on poverty, but the distribution of the benefits still depends on the context. Devres (1981) has argued, that the larger and wealthier farmers are more likely to take advantage of new inputs, better technology and extension services, as well as to respond to new market opportunities following road improvements, and thus the improvements in production and marketing are likely to have implications for income inequality.

Besides transportation costs, market institutions form the other part of the marketing margins, namely transaction costs. “Poor road infrastructure increases transportation costs but this is not the only factor. The institutions through which the food collection is organized also generate costs, i.e. transaction costs which are influenced by road infrastructure.” (Minten & Kyle 1999, p. 468) Decreasing other marketing margins e.g. by providing better access to markets might not lead to expected trade outcomes unless trade has been made possible by established institutions. This point has been highlighted in Winter-Nelson and Temu (2002) in their case study of the Tanzanian coffee market. The study was based on a survey of 159 farmers, eight traders and eight exporters in Arusha region. The authors divided marketing margins into two parts: transaction costs (such as negotiating contracts, accessing credit and enforcing contracts), and transformation costs through space, form and time. The hypothesis for the study was that market liberalisation could simultaneously reduce transformation costs and increase transaction costs if competition leads to lower assembly and transportation expenses but higher costs of negotiating and enforcing contracts. The overall impact at the coffee market was still favourable as the marketing margins dropped substantially after liberalization resulting in a large change in the producer prices. Also in another article by the same authors it is argued that the liberalisation of the coffee market in Tanzania has been a success leading to increasing producer prices, declining marketing margins and continued provisions of marketing services (Temu et al. 2001). They arrived to the conclusion after estimating regression parameters using Generalised Least Squares (GLS) for a panel data on auction prices.

1.2 Welfare Analysis on Lower Marketing Margins – CGE Literature

The impact of a change in the marketing margins and its cumulative effect on prices, trading volumes, and welfare of different groups nationwide has important policy implications, but these links are difficult to establish from partial equilibrium analysis. Thus, several researchers have used the computable general equilibrium (CGE) framework to model the likely impact of facilitating market access and removing trade barriers in order to predict the effects of the policy, and to trace the links that lead from the policy change to the change in welfare at household level (see e.g. Hertel et al. 2004). A general overview of the welfare impacts of trade liberalisation is provided by Hertel *et al*. (2003) who analysed the extreme case of total trade liberalisation in a cross-country study of fourteen developing countries. The authors stress the importance of adjusting the reforms for local circumstances but conclude that even though the effect of trade liberalisation is positive in general, in the short run the poorest groups may well be adversely affected by a rapid change that has not been compensated by other means. As the poor tend to be more reliant on one source of income, the changes in prices and wages put them in a vulnerable position. Furthermore, the authors conclude that merely focusing on international trade liberalisation may not be assumed to be the solution for the poverty problem even at aggregate level.

The concern of reverse poverty impact of trade liberalisation despite enhanced overall growth was addressed by Löfgren (1999) who analysed the short run effects of removing tariff and non-tariff barriers from agriculture and industrial sector in Morocco. In order to mimic the true circumstances in the welfare analysis, he incorporated country-specific characteristics, such as large wage gaps, labour market segmentation, and different sectoral structure, in the model. The simulations show that cutting the formal barriers would result in significant aggregate welfare gains while the rural poor would loose in the process in the short run. In the long run the benefits are more evenly distributed. However, if the reduced boarder protection can be introduced in a context of a policy package that includes income transfers and government investment in education and infrastructure, the rural poor can be protected from the adverse effects of trade liberalisation. The study also highlights the importance of well functioning infrastructure and capacity building to enable the poor to exploit the benefits provided by the new, more open economy.

Löfrgen's argument of the importance of infrastructure and know-how falls into the ongoing debate on the importance of the informal trade barriers. However, very few studies analysing the impact of these informal trade barriers in the CGE framework have been published. An exception and a valuable contribution to the discussion about the domestic barriers is a study by Arndt *et al.* (2000).

They concentrate explicitly on analysing policies aimed at facilitating domestic opportunities for trade by decreasing the domestic marketing margins. They use a static CGE-model to simulate decrease in marketing margins and increase in agricultural productivity in Mozambique. The authors modelled three possible scenarios: 1) increase in productivity by 30 percent for all agricultural products, 2) reduction of marketing margins for all goods by 15 percent, and 3) combination of the two. The model formulation incorporated home consumption and marketed consumption through linear expenditure system where the marginal budget shares of marketed and non-marketed goods were fixed. It also assumed labour supply to be fixed but land to be abundant. The authors found that improving agricultural technology and lowering marketing margins yield gains across the economy, but with differential impact on factor returns. While they found that a gain in agricultural productivity would lower agricultural prices and cause the cost of living index to fall, the authors also argue that lowering marketing margins would increase producer prices in agricultural sector and increase the relative cost of living for rural households with significant home consumption. The combined scenario reviled significant synergy effects as welfare gains exceeded the sum of gains from the individual scenarios. These results support the argument of the need to facilitate the opportunities for trade in the domestic markets if real benefits from liberalising international trade are to be exploited.

1.3 Current Approach

The aim of the current study is to expand the discussion on welfare analysis of market access and trade costs into the country context of Tanzania. The Tanzanian government is currently preparing a new agricultural marketing policy, and concrete programmes for improving infrastructure and facilitating trade have been designed. Even though several small-scale partial equilibrium studies of the expected consequences have been published, no estimates of the economy-wide gains of these efforts have been presented so far. The current study aims at contributing to the discussion by estimating the welfare impacts of two marketing interventions: infrastructure improvement and enhancement of trading environment. The current approach also contributes to the methodology of analysing welfare changes by elaborating the analysis from static framework into dynamic recursive framework that allows to predict the changes in welfare in the near future as well as to compare counterfactual scenarios against the set development goals to which explicit timeframes are attached. The model also incorporates a more elaborate production technology than the previous studies, which allows more accurate welfare analysis to be done. The current study uses a relatively new dataset that, to my knowledge, has not been used in other studies before. The data consists on a social accounting matrix (SAM) that gives a snapshot of the Tanzanian economy in 2001. The

original SAM was developed by IFPRI in 2003 (Thurlow & Wobst 2003) but for the purpose of this study it has been modified with recent information on regional production levels and transportation costs, to enable close analysis on the impact of lowering the marketing margins.

In particular, two aspects of facilitating trade through lower marking margins are considered: the regional aspect, and the impact on commercialisation. Instead of analysing the differences between a variety of crops, as done in Arndt *et al.* (2000), the first set of simulations analyse a few aggregate categories of crops produced in different geographical locations. This brings out the regional dimension of the marketing margins as the sectors located in a remote area are faced by higher transportation margins than other areas. Previous studies have found infrastructure and trade barriers to be an important explanatory factors for regional disparities in economic performance. Nagaraj *et al.* (2000) investigated regional differences across Indian states from 1970 to 1994, and found that the regional differences in road infrastructure was an important explanatory factor in different growth rates across regions, even though over time there is evidence of convergence. Deichmann *et al.* (2000), on the other hand, analysed the differences in regional production in Mexico concentrating on firm level characteristics as well as external characteristics such as infrastructure. The authors concluded that firms differ substantially between the regions and their access to markets, i.e. the size of potential markets that could be reached given the density and quality of road infrastructure in the region, is a significant factor in the regional productivity. Besides these econometric studies, also CGE approach has been used to analyse regional differences. The studies fall mainly into two categories: partially regionalised and fully regionalised models. An example of the former is Harris (2001) who analysed the regional effects of agricultural policy reforms in Mexico. The model captures regional differences in terms of production and consumption, i.e. rather than having complete regional social accounting matrices, the model regionally disaggregates only production and factor markets as well as households. This allows the author to separate the regions to analyse labour migration and other country specific policy issues that are related to spatial differences within the country, without loosing the overall picture of the nation-wide implications. The methodology of regionalisation was taken a step further by Löfgren and Robinson (1999) who built a prototype of multi-region CGE model for a stylised African country with rural regions that are linked to urban areas with high transaction costs. The model divided all the production and consumption by region allowing the regions to trade with each other. The results highlight the importance of taking spatial differences into account when discussing improvements in transportation margins.

Also in Tanzania lowering the transportation costs is likely to induce changes in the regional production structure as the remote producers become more competitive. A recent study by Fan *et al.* (2005b) argues that the improvements in infrastructure would lead to largest welfare gains in the Central and Southern regions of Tanzania, that currently are underdeveloped in terms of roads and technology. In the current study the agricultural sectors have been divided into 21 regional producers with identical production technology but differentiated trading margins. The focus is on overall production and thus no difference is made between commercial and home production. The model adopts the partially disaggregated approach separating only the agricultural production by region, but allowing the goods to be traded at a national market. In Tanzania, the national market is represented by the markets in Dar es Salaam. They service the urban population but also work as a necessary link between the rural regions that are usually not connected to each other by a passable road. The regional differences in production are introduced through changes in the transportation margins into Dar es Salaam. The choice of the partial regionalisation over full regionalisation is imposed by the lack of more elaborate data. The partial regionalisation will give relevant information on the welfare results at the national level, and important insight into the regional production patterns, but it disguises some information on the regional distribution of the welfare implications. However, the model can give interesting information on the regional changes in agricultural production due to improvement in trade services, and as the agricultural sector is the most important source of income for the poor households, regional agricultural production should also work as indicators of regional welfare changes. Still, due to the limitations of only partially regionalising the model, the specific changes in consumption and welfare within each population group are mostly discussed at national level.

Besides overall productivity gains for different regions, the literature also suggests that the growth results in a shift from subsistence farming into commercialised agriculture as access to market improves and trade margins decrease. As Biswanger *et al.* (1993) argue “the major effect of roads is (…) on marketing opportunities and reduced transaction costs of all sorts” (p. 364). Existing trade and transportation margins lead to lower trading volumes. Minten and Kyle (1999) analysed survey data collected from traders in former Zaire, and concluded that food prices vary significantly due to poor transportation infrastructure. A poor quality road doubles the transportation cost leading to higher wedge between the producer and consumer price and thus lower gains from trade. On the other hand, liberalisation efforts and abolishing informal market barriers have reported to have lead to substantial increase in market integration and economic growth as shown in a study on Bangladesh (Goletti 1994). The second set of simulations in the current study concentrates on the

aspect of commercialisation. Here the agricultural producers are divided into commercial and subsistence producers, and only commercial producers demand trade and transport services. As the trade margins are reduced, the commercial sector becomes more competitive and there is likely to be a shift from subsistence production into commercial production, which is captured in the model.

Most of the recent welfare studies have been made in a static framework that does not incorporate the growth of the economy into the model. This approach has been criticised by Rutherford and Tarr (1998) among others. They argue that growth is the most important source of poverty reduction when conditions for trade are improved, and unless growth is taken into account, all estimates of welfare gains in constant return to scale models are likely to be modest. The current study takes this criticism into account by constructing a dynamic recursive model that aims at projecting the economy up to the year 2015 that was set as the dead line for the Millennium Development Goals (MDGs). A central research question is to discuss the changes in the welfare of different population groups, and in particular, provide a projection on whether the MDGs could be reached with and/or without improvements in trading environment.

The rest of the study is organised as follows. Section two presents the data used and discusses the adjustments made. Section three introduces the structural model, and section four presents the simulations used to model different future scenarios in order to gain insight in the welfare implications of different policy options. Section five discusses the results gained from the simulations, and finally section six concludes.

2. Social Accounting Matrix (SAM)

2.1 Original SAM

The main dataset used for this study is the social accounting matrix (SAM) constructed for Tanzania by Thurlow and Wobst (2003). The SAM documents the structure of the economy in the year 2001. The previous database available for CGE modelling was the 1992 SAM based on household and labour force surveys from the beginning of the 1990s and input-output table from 1976. The main strength of the current SAM is the use of up-to-date data sources that allows more detailed poverty focused description of the economy to be constructed. The SAM is based on the most recent data available including the input-output table for 1992 (NBS 1999), 2000/01 Household Budget Survey (HBS) (NBS 2002a), and 2000/01 Labour Force Survey (LFS) (NBS 2002b).

A SAM is a comprehensive, economy-wide data framework that traces all incomings and outgoings of the agents in the economy.[1] Usually a SAM is represented as a square matrix in which each account is represented by a row and a column. Each cell shows a payment from the account of its column to the account of its row, i.e. the incomes of the agent appears along the row whereas its expenditures appear along its column. As the SAM is a comprehensive representation of the economy, for each account the total revenue (row total) must equal total expenditure (column total). The SAM usually has a separate account for all activities (i.e. producers), commodities (i.e. markets for goods and services produced by activities), factors, trading margins, government and tax accounts, households, enterprises, and the rest of the world. In the SAM constructed by Thurlow and Wobst (2003) there are 43 productive activities producing 43 commodities. Out of these sectors 21 are in agriculture, giving a detailed view of the sector that covers half of the country's GDP. The two sectors of special interest for the current study are the trade and transportation sectors that form the marketing margin. The SAM has also a detailed disaggregation of the factors of production separating all factors used in subsistence production (so-called subsistence factor), different categories of skilled and unskilled male, female, and child labour, land, and finally agricultural and non-agricultural capital. A detailed classification of the factors enables the analysis of subtle changes in poverty when the relative prices of the factors change. The separation between male, female and child labour allows also the analysis of gender differences in the labour market, and the extent to which a proposed policy would affect the demand for child labour that at present accounts for 8.6 percent of the total workforce (Thurlow & Wobst 2003). The households are also disaggregated into rural and urban poor and non-poor household categories allowing for the welfare analysis between different household groups. However, no movement is allowed across the household groups, and in particular a poor household cannot move into rich household group even if its income would be substantially increased. This income-dependent categorisation is aimed at identifying the people *currently* living in poverty in order to allow analysis on changes in their welfare. During the simulations the income of the poor households may well increase so that some of the households rise above the poverty line and, by definition, become non-poor, but in order to identify the welfare change in households who are currently poor, the household categorisation is held fixed throughout the simulations. The changes in poverty status of the households are discussed separately in the welfare analysis.

[1] For an overview, see Löfgren *et al.* (2002) and for a general discussion of SAM-based modelling, see Pyatt and Round (1988).

2.2 Adjusted SAM

Even though highly disaggregated, the original SAM cannot be readily used for the current study. The SAM needs to be cleaned and re-aggregated in order to analyse the impact of improving trade. For example the tourism sector, that is the largest export item in the country, has been included into domestic transport sector in the original SAM. As the focus of this study is to estimate changes in transportation, the tourism sector is separated out from transport sector and re-aggregated with a new service sector. Re-ordering of the accounts is also necessary in order to bring out the regional aspect of the production and trade. The agricultural production has first been aggregated up into two groups, food crops and cash crops[2]. The crops classified as food crops are mainly cultivated for the domestic markets, have similar trading margins, and account for a high share of household consumption. The cash crops, on the other hand, are high-value goods mostly cultivated for the export market. The producers of food crops and cash crops have then been divided into the 21 administrative regions in Tanzania based on the most recent production data from the Ministry of Agriculture and Food Security.[3] In the original SAM the activities produce goods for marketing and subsistence, whereas the commodities 'buy' the goods alongside with trade margins, i.e. retail and wholesale services, to enable trade at the national market. In the adjusted SAM, the regional producers 'buy' trade and trade services directly as an intermediate input.[4] The regional producers differ in the magnitude of the trading margins they need to sell their products. The share of the trade and transportation costs for each region is allocated according to the volume of the regional production and the transportation costs from each region to Dar es Salaam. The estimates of the transportation costs were obtained from the transporters in Dar es Salaam, and cross-checked with transporters in other regions. The benefit of using the estimates from the market rather than the official fares is that the market takes into account not only the distance but also the quality of roads, safety and reliability of the transport. For details on the production shares and transportation costs, see appendix 1. The regionalisation of the model has been done using the so-called top-down approach, i.e. dividing the aggregate volumes of production reported in the SAM by the shares of regional production calculated from the regional production data. This method does not result in the exact same estimates for the regional production as the original regional data, but it assures the

[2] The food crop sector consists of all the producers of maize, paddy, sorghum, wheat, beans, cassava, cereals, oil seeds, roots, other fruits and vegetables, and other crops not mentioned elsewhere. The cash crops, on the other hand, consists of the producers of the main agricultural export items including cotton, coffee, tobacco, tea, cashew nuts, sisal, and sugar. The classification of different crops is based on the classification used by the Tanzanian authorities (see e.g. Ministry of Works 2002), and their different characteristics in the data. Food crops are mainly produced and consumed domestically whereas cash crops are, to large extent, sold abroad.

[3] Data for the regional production of non-agricultural sectors could not be obtained for this study.

[4] This also implies that the difference between home produced goods and marketed goods on the consumption side is no longer present in the model.

balancing of the SAM and the compatibility of the regional data from various sources with the official national accounts.

For the analysis of the subsistence vs. commercial production, the classification of the producers has been changed. Instead of having regional producers selling products to the market, the new SAM identifies subsistence and commercial producers at the national level. This classification allows analysis of the relative production changes between the formal and informal sectors as trade is facilitated. The subsistence sector uses only ‘subsistence factor’ in their production that covers informal labour force, inherited land, and the use of family owned assets, such as cows and tools. The commercial sector, on the other hand, buys its inputs from the factor market, and purchases also trading and transport services in order to get the products to the market. The list of the new accounts and the final SAMs are included in the appendix 2 and 3.

2.3 The Structure of the Economy

In order to understand the changes in the economic structure, it is important to study the starting point, i.e. the structure of the economy in the base. The SAM provides useful information of the economy and the relative importance of the different sectors. It serves also as a basis for hypothesis of the impact of a shock. The macroeconomic structure of the economy is shown in table 1.

	Share of value added	Share of total output	Share of employment	Share of exports	Export-output share	Share of imports	Import demand share
Food crops	30.4	19.4	25.6	3.2	2.4	3.3	4.0
Cash crops	4.9	4.3	8.0	24.3	51.9	2.5	17.3
Livestock/Fishing/Hunting	10.9	6.7	13.1	5.9	9.9	0.2	0.6
Trade	10.5	7.0	2.7	N/A	N/A	N/A	N/A
Transportation	5.3	3.5	1.4	N/A	N/A	N/A	N/A
Processed food	5.8	11.3	3.2	1.2	1.0	5.4	7.4
Manufacturing	12.2	14.1	18.0	4.8	3.1	63.5	40.7
Services	20.0	33.8	28.0	60.6	18.6	25.1	12.7
TOTAL	100.0	100.0	100.0	100.0	10.5	100.0	15.9
Total agriculture	46.2	30.4	46.8	33.4	13.9	5.9	4.8
Total non-agriculture	53.8	69.6	53.2	66.6	9.3	94.1	18.9
Total	100.0	100.0	100.0	100.0	10.5	100.0	15.9

Table 1: The structure of the economy. Source: Author.

Agriculture plays a significant role in the Tanzanian economy as a source of production and employment. It accounts to roughly half of the country's production of value added and it is the single largest employer of domestic labour. The production of food crops is mainly consumed domestically, and domestic producers are also the primary source of supply for local consumers. This implies that the sector is rather isolated from the world market and does not respond to the changes in the export and import prices. On the other hand, cash crops are largely sold abroad at the world market as the domestic market for the products is limited. Cash crops are the second largest export item in Tanzania, preceded only by the ever-expanding tourism sector. The trade sector covers domestic retail and wholesale services and, thus, by definition these services are neither imported nor exported. The sector plays a significant role in facilitating domestic trade but it also introduces an additional cost in terms of marketing margins. In fact, 40% of the intermediate input demand in the agricultural sector consists of trade services whereas the proportion in the other sectors is 10% or lower. Similarly the transport sector is assumed to be a purely domestic sector with no trade with the rest of the world. Trade and transport, that are assumed to account for the marketing margins within the country, are non-trivial in size: in fact, they account for a larger percentage of the value added than all the manufacturing sectors combined, which highlights the importance of facilitating trade and releasing resources from trading margins into other production. The manufacturing sector is the third largest sector in the country after agriculture and services. Manufacturing industry is also the heaviest user of imported inputs. The output of the manufacturing sector is mainly consumed domestically whereas the service sector constitutes the majority of Tanzania's exports. This is due to the fact that tourism, which is the main source of foreign exchange in Tanzania, is accounted for in this sector.

3. The Model

The general model adopts neo-classical-structuralist approach to CGE modelling that follows from the work by Dervis *et al.* (1982) where agents respond to price changes. The model used is based on the IFPRI standard model documented in Löfgren *et al.* (2002) that has later on been updated[5]. According to the neo-classical tradition, the model can be described as a single-country, small open economy where the households are assumed to maximise their consumption as a proxy for utility, and the producers maximise profits. The model is Walrasian implying that it determines only relative prices. In the current model the consumer price index is selected as a *numéraire* and thus its

[5] The base model used in this study is version 1.02 extended by Sherman Robinson based on Version 1.01 coded by Hans Lofgren, Sherman Robinson, and Moataz El Said that on its part is an updated version of 1.00 coded by Hans Lofgren, Sherman Robinson, Rebecca Lee Harris, Moataz El Said, and Marcelle Thomas.

value is fixed at one. The model is, by construction, homogenous of degree zero in prices and thus doubling of the value of the *numéraire* will double all the prices but leave real quantities unchanged. In other words, only relative prices matter in the model, and these prices are compared with the consumer price index selected as the fixed base.

In order to capture country-specific characteristics of the Tanzanian economy, the structure of the basic model is adjusted away from the neo-classical tradition and due respect is paid to the structural aspects of the economy. These adjustments to the standard model are in focus in this section when the model is described. The complete model variables, parameters, and their links to each other are presented in appendices 4 and 5. The model is solved using the General Algebraic Modeling System (GAMS).

Prices and Marketing Margins

First deviation from the neo-classical model is the empirical fact that trade is costly. In the current model, trade and transport services feed into the commercial production as an additional input required to produce goods that are sold at the market. These costs differ across producers by region and by market orientation. Not all producers face the same costs and same production technology, and the decision to engage in trade in the first place is costly, unlike the neo-classical framework would assume. Lowering the cost of trade will improve the competitiveness of the trading sectors in an un-symmetric way depending on how large share the marketing costs are of the sector's total costs. This, on the other hand, changes the production patterns across regions and between formal and informal sector. Unlike in the standard model, the cost of trade and transport is incorporated in the cost of the composite good as an intermediate input, and thus no trade margins are added to the price of the final good. Transportation costs are already incorporated in the price of the good and not as an explicit wedge between the consumer and producer price. The producer pays a higher price for production, which increases the selling price faced by the consumer. It is important to bear in mind that the subsistence producers do not purchase any trade and transport services as the goods are domestically produced and consumed at home.

Trade and Production

Secondly, the production technology in the current model is interestingly different from the standard model. As discussed above, the producers are assumed to maximise their profits subject to their technology taking prices as given. The production technology is a combination of intermediate inputs and primary factors of production and both intermediates as well as primary factors are

nested into aggregate intermediate and aggregate value added components that feed into the production. In the current model as well as in the standard specification, the combination of intermediates and primary factors is determined by a Leontief function where fixed coefficients establish the use of each input. In order to produce the aggregate value added, however, the current model deviates from the standard model. Instead of using constant elasticity of substitution (CES) technology between the primary factors, or even more restrictively Cobb-Doublas (CD) production function, the current model uses a more general transcendental logarithmic, or simply translog production function to represent technical tradeoffs (see e.g. Varian 1992, Greene 2003). The benefit from using the translog for modelling production is its flexibility: there are no *a priori* restrictions imposed on the function and, in particular, the elasticity of substitution is not restricted. This allows elaborate nesting structures to be used to combine different factors of production, and various elasticities of substitution to be used to substitute one factor to another. The translog function can be easily adjusted to accommodate an arbitrary number of nesting and substitution elasticities in the production. The elaborated nesting structure is likely to give a more realistic description of the production technology than the previously used functional forms. For the purpose of the current model, the following production structure was defined for agricultural commodities (see figure 1).

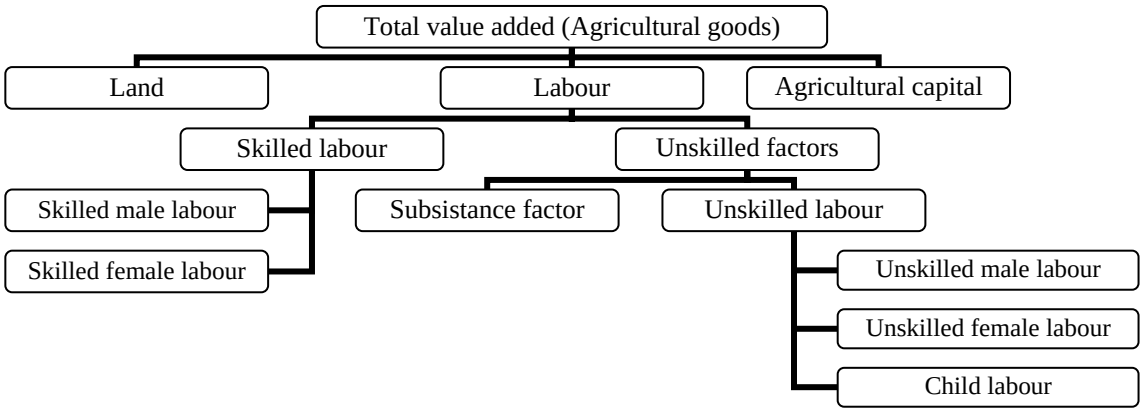

Figure 1: Nesting of the primary factors of production for the agricultural goods.

For non-agricultural commodities, on the other hand, the production technology is defined as presented in figure 2.

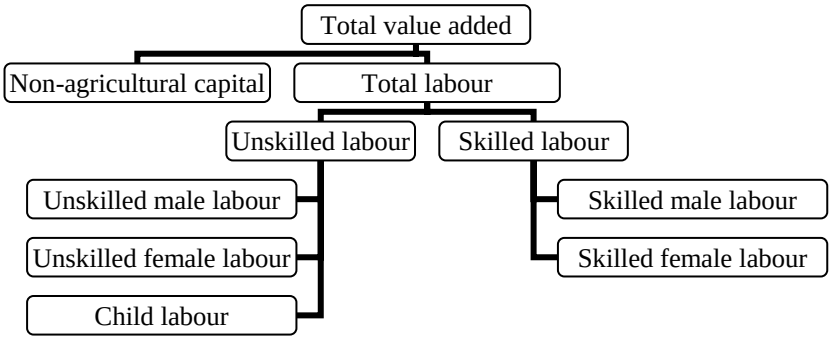

Figure 2: Nesting of the primary factors of production for the non-agricultural goods.

The agricultural and non-agricultural sectors also differ in their substitution elasticities between the factors. The main difference is that in the agricultural sector labour markets are segmented by gender and thus female and male unskilled labour is made relatively difficult to substitute with each other, whereas in the less traditional non-agricultural sector men and women are much closer substitutes. In the higher education groups gender plays lesser role and thus the substitution elasticity between the skilled labour categories is high in both sectors. In absence of econometric estimates of the nesting or the substitution elasticities of such a detailed set of factors, the elasticties used in this study were determined based on discussions with Professor Sherman Robinson, knowledgeable Tanzanian counterparts, and author's own judgement. The full set of imposed elasticities used in the model is presented in appendix 6. As the absolute figures can be debated, the impact of using different values is tested in the sensitivity analysis (see appendix 7). The results prove not to be sensitive to changes in elasticities. Furthermore, in the second set of simulations, where subsistence producers are introduced, the production function in these sectors is modelled as a simplification of the agricultural production. The subsistence farmers use, by definition, subsistence factor in their production as their only input.

In order to operationalise the graphical description of the function, the mathematical form can be derived by logarithmically differentiating the general total cost function under constant returns to scale as done in Greene (2003). If one identifies the derivatives as coefficients and impose the symmetry of cross-price derivatives, then the function turns into the standard tranlog function presented in equation (3.1) where ava_a is constant, $afva_{fa}$ is an intercept, $\gamma_{ff'a}^{va}$ is cross price

substitution elasticity, and $WF_f \cdot WFDIST_{fa}$ is the wage paid for each factor *f* in each sector *a*. The function calculates an aggregate price index $Log\left(PVA_a\right)$ that will implicitly determine real output.

$$Log\left(PVA_a\right) = ava_a + \sum_{f \in F}\left(afva_{fa} \cdot Log\left(WF_f \cdot WFDIST_{fa}\right)\right) +$$

$$+\frac{1}{2} \cdot \sum_{f \in F}\sum_{f' \in F}\left(\gamma^{va}_{ff'a} \cdot Log\left(WF_f \cdot WFDIST_{fa}\right) \cdot Log\left(WF_{f'} \cdot WFDIST_{f'a}\right)\right) \qquad a \in A, f \in F \quad (3.1)$$

The production technology also defines the shares of a given factor used in the production ($SFVA_{fa}$), i.e. factor expenditure shares in a log function, where QVA_a is the quantity of value added in sector *a,* is defined as follows (3.2):

$$SFVA_{fa} = afva_{fa} + \beta^{va}_{fa} \cdot Log\left(QVA_a\right) + \sum_{f' \in F}\left(\gamma^{va}_{ff'a} \cdot Log\left(WF_{f'} \cdot WFDIST_{f'a}\right)\right) \quad a \in A, f \in F \quad (3.2)$$

Finally, factor demands can be derived as done in (3.3), where QF_{fa} is the quantity of factor *f* employed in sector *a*, and tva_a is a tax on value added in sector *a*. The wage paid for each factor of production times the quantity of the given factor used in the production must equal the factor expenditure share multiplied by the price of total value added (net taxes) and total quantity of all value added in a given production.[6]

$$WF_f \cdot WFDIST_{fa} \cdot QF_{fa} = SFVA_{fa} \cdot PVA_a \cdot \left(1 - tva_a\right) \cdot QVA_a \qquad a \in A, f \in F \quad (3.3)$$

The rest of the production and trade equations are defined as in the standard model and follow closely the description given in Löfgren *et al.* (2002). The demand for individual intermediate inputs is determined simply by a standard Leontief formulation, i.e. the quantity of a good used as intermediate output in a given activity is determined by a fixed intermediate input coefficient. Once the production has been modelled, the produced quantities from each activity are allocated into market sales. In the standard model a share of the production is diverted into home consumption. However, in the current model, the distinction between home production and marketed production is done in the production side so that commercial sectors buy transport services whereas subsistence

[6] The coding of these formulas into GAMS was originally done by Sherman Robinson.

producers do not. All the output from both producers is sold to the consumers. The total marketed production of a given commodity is determined by the sum of activity specific marketed production of the given commodity through a CES function. The rate of substitution is restricted to guarantee the function's convexity to the origin, which in turn can be interpreted as the rule of diminishing technical rate of substitution. The optimal quantity of the commodity from different activities is inversely related to the activity specific price. A decline in one activity specific price relative to another would shift the demand in favour of it, but would not totally eliminate the demand for other producers. In the current model, twenty-one regional producers are producing the same product of cash crops and food crops, but they experience different shock in cost structure as trade and transportation services improve due to differences in their trading margins. The final products are modelled to be highly substitutable with each other, but not perfect substitutes, which avoids the problem of perfect specialisation into the most productive areas.

Apart from selling to the domestic market, the domestic producers may also sell their products abroad. The model allows imperfect transformability between the markets, and a constant elasticity of transformation (CET) function is specified to model the marketing behaviour. The CET function is very similar to the CES function, but in the case of CET the elasticity of substitution is negative. The goods sold at the domestic market may be domestically produced or imported from the rest of the world. Here similarly to the case of different producers of the same good within the country, also the domestic and foreign producers of one good are assumed to be somewhat different. This imperfect substitutability is captured by a CES-like function where the domestically supplied good is a constructed aggregate of domestic and imported supply. Goods from different sources can be substituted for each other according to the elasticity of substitution. This combined supply function is also known as Armington function.

Institutional Accounts

The institutional section specifies the behaviour of the government and the households in the model, and details their incomes and outgoings. The behaviour is modelled as in Löfgren *et al.* 2002. Firstly, the total income paid for all primary factors of production is defined as the sum of wages paid for each individual. All primary factors are owned by domestic institutions, and thus the total factor income is divided between them in fixed shares, after direct taxes and transfer payments to the rest of the world have been deducted. Apart from getting payments for primary factors owned by the households, private households can also gain income in form of transfers from other households, government, or rest of the world. Household's disposable income is defined as total

gross income net of transfers, savings, and taxes. The households maximise their utility subject to their budget constraint. Their behaviour is determined by the first order conditions where household income is consumed on marketed commodities. These functions form a so-called linear expenditure system (LES), as spending on each individual commodity is a linear function of total consumption spending. The function includes a minimum level of consumption that does not depend on income, and an income-dependent consumption as a linear function. Apart from consumption, goods are also demanded for investment and government consumption. Government consumption refers to public services provided. Besides consumption, government income can also be used for direct transfers. The total government spending is thus the sum of government consumption and net-transfers.

System constraints

Finally, as the model simulates a closed economy all markets must clear and accounts must balance. The clearing mechanism or 'closure' defines how the world is assumed to be functioning. The same model can be used to model flexible or fixed exchange rates, unemployment or full employment, and savings-driven investments or investment-driven savings. The choice of the closure has a significant impact of how the equilibrium is obtained and how the results turn out. The specific macroeconomic structure chosen for the current model on Tanzania is based on knowledge of the country-specific circumstances as discussed below.

Firstly, factor markets are set to clear by making total aggregate demand for each factor over all sectors equal to total supply of factors. For the current simulations, different methods of clearing the markets are selected for different factors of production depending on their availability in Tanzania. Capital is assumed to be fully employed and fixed in supply, which implies that the wage paid for capital changes to adjust the demand to equal the fixed supply exactly. Given the reasonably long time period for the simulations from 2001 up to 2015, capital is assumed to be mobile between sectors. This will lead to equal wages paid to capital in each sector. On the other hand, unskilled labour is assumed to be in elastic supply and mobile between sectors, implying that the producers are able to employ as much unskilled labour for a fixed wage as they want. The unskilled labour force is able to move between sectors but, as the movement from farm to the urban manufacturing sector is not likely to be smooth, the mobility of the workers is still restricted by the use of substitution elasticities in production. As it is relatively difficult to substitute capital with labour, and as the supply of capital is fixed, also the labour force remains at their respective sectors to large extent. Agriculture is the largest employer in Tanzania, which absorbs the labour that is not

employed in other sectors and which is able to employ large numbers of people with low wage. Still the unemployment figures in Tanzania are high: according to the latest Labour Force Survey (NBS 2002b) the level of unemployment out of economically active population was 7% and underemployment additional 11%, which justifies the unemployment assumption to be used. On the contrary, highly skilled labour (secondary education or above) are not assumed to be unemployed, but fully employed and mobile across sectors. Finally land is assumed to be unemployed and thus all sectors may employ as much land as they desire for a fixed wage while the supply adjusts. This is not to say that Tanzania would gain more land as the economy grows, but that the land is currently under-utilised to the extent that the quantity of land is currently not a binding restriction for production. This assumption can be justified given the recent calculations by the Tanzanian government that Tanzania is currently using only 5 percent of its land surface and 30 percent of its available arable land for cultivation. Thus for the cost of clearing and maintaining a farm, producers are able to increase their use of land, should they wish to do so.

Commodity markets must also clear so that composite supply equals total demand from intermediate use, household consumption, government consumption, investment, stock change and trade input use. The market clearing takes place through supply and demand prices at the domestic market but at the import market, where the world price is fixed, the supply for imports adjusts. Also the current account for the rest of the world must balance. The current account is expressed in foreign currency and it equates the country's spending and earning of foreign currency. In the current model, the level of foreign saving is fixed and the equality is achieved by flexible exchange rate. This closure is justified as the Tanzanian shilling is indeed floating, and the foreign savings are largely constituted by aid flows that are not likely to adjust according to the government spending. Furthermore, the domestic government is operating under a budget constraint and the total government revenue must equal total government spending (except government investment) and savings. Government savings are flexible and may also be negative in case government spending exceeds its revenue.

Savings must equal investment in the model. In the selected closure the savings and investment adjust together for the exogenous shock in absorption. The shock in absorption is divided between the components of aggregate absorption given the shares for investment and government consumption (which means that also the share for household consumption is implicitly determined). Under this specification, any change in total nominal absorption is spread evenly across investment, government consumption and household consumption given their fixed shares of the absorption.

The savings adjustment, which is determined by changes in investment and government consumption, determines the disposable income for household consumption. As all components of absorption adjust together, this macroeconomic closure is said to be balanced.

Introducing Dynamics

The base model is a description of the economy at present and it provides a useful starting point for simulating possible counterfactuals in a static framework. However, modelling growing economy requires a dynamic model that is able to mimic the improvement of production technology, growing capital stock and population over time. The dynamic model used for this study belongs to the recursive dynamic strand of the CGE literature, which implies that "the behaviour of its agents is based on adaptive expectations, rather than on the forward-looking expectations that underlie alternative inter-temporal optimization models" (Robinson & Thurlow 2004). Alternative ways of modelling dynamics have been discussed in the literature broadly at theoretical level, but the dynamic empirical forward looking CGE models are still rare[7]. The dynamic recursive model is commonly used as a reasonable approximation of the growing economy as it captures the main idea of economic growth as agents respond to the growing supply of resources recursively. The current model simulates the evolving economy by solving the equilibrium for one period at a time, and the base values are updated to reflect the growing economy after each simulation. The dynamic additions to the IFPRI base model are done according to previous work by Robinson and Thurlow (2004).

Firstly, in the dynamic model the population grows over time. According to the latest Tanzanian population census from 2002, the total population in the mainland was estimated to grow by 2.9 percent annually. To model this growth, the household consumption expenditure functions are adjusted in the dynamic simulation to project higher consumption demand. The expenditure function for traded commodities is constructed from a part that is independent of income and a part that is bound by disposable income. The part that is not dependent on income can be thought of as a minimum level of consumption measured at the market prices or as the intercept of the demand curve. On the other hand, the upward sloping consumption demand is portrayed by the positive relationship between the household's income and the level of consumption in the latter part of the equations. Under the Linear Expenditure System (LES) specification, this relationship is reflected by constant slope of the consumption curve. The population growth is assumed to shift the

[7] For an example of a rational expectations CGE model, see e.g. the DREAM (Knudsen *et al.* 1998).

household consumption upwards, i.e. rising the constant term for minimum level of consumption without affecting the slope of the function. In other words the new demand curve shifts upwards parallel to the old demand curve. The new consumers are assumed to share the same preferences as the old consumers, and thus the growing population shows as a change in average consumption demand leaving marginal demand unchanged.

Secondly, also labour force is assumed to grow at the same rate as the overall population. Ideally it would be preferable to model the growth of each of the labour categories separately, but as data on labour force growth rates by education category are not available, and as the simulation time frame does not allow for drastic changes in the education of the labour force, the general growth rate is accepted as a reasonably approximation. The labour force is assumed to grow, on average, by 2.9 percent annually. In the current model the firms are assumed to be able to employ unskilled workers also from a pool of unemployed labour. The assumption of unemployment implies that the wage of the unskilled labour remains fixed and the firms can employ unlimited number of workers for that price. However, as the simulation is run from 2001 up to 2015, it would be unrealistic to assume that the wage rates would not increase at all. Thus an exogenous growth on the wage at the unskilled labour force sector is imposed by growing the fixed wage by one percent per year. On the other hand, highly skilled workers, i.e. people with secondary education or above, are not assumed to be unemployed and thus the pool of skilled workers can only grow as fast as the population in general. Thus, the supply of skilled workers is assumed to be fixed and fully employed. The fixed supply is adjusted exogenously to grow by 2.9 percent every year, the new base values are updated for the next year's simulation, and the wage is left endogenous to match the supply and demand. As the demand for labour is assumed to increase with the growing economy whereas the supply for educated labour grows slowly, the widening of the pay gap is likely to take place.

Thirdly, the foreign aid has grown by roughly five percent over the recent years (EIU 2004a), and the growth of foreign resources is also taken into account in the current model. As the foreign savings have been fixed in the base model, the savings are exogenously grown in the dynamic model by increasing the variable.

The fourth element adjusted in the dynamic simulation is capital accumulation. In the static model the capital supply is exogenous and unaffected by investment. In the dynamic model the current level of the capital stock depends on the previous level of capital as well as investment spending. The allocation of the new capital between the sectors mimics the behaviour of an investor who

bases their expectations on the sector's future on its past performance. Thus the quantity of new capital going to each sector depends on the aggregate capital income of profits as well as the sector's profits in relation to other sectors. More profitable sectors receive a greater share of the new capital than others. However, the new investments are also used to pay for increased maintenance costs due to road improvement modelled in the simulations. This is done by diverting a share of new investment out of capital accumulation i.e. out of the model, as these resources are no longer available in the economy.

Finally, the economic growth is also modelled through productivity growth. As the translog function is used for modelling the production in the base model, also the productivity adjustment differs from the standard recursive dynamic model. In the translog function, the productivity increase is obtained by decreasing the value of the constant (ava_a) in the production equation 3.1. Decreasing the constant in a log-function by, for example, one percent increases the value of the function by one percent. In the base simulation all sectors are assumed to become one percent more productive every year.

4. Simulations

4.1 Scenarios

The aim of the simulations is to demonstrate the impact of improving transport infrastructure and trade practices in Tanzania where subsistence farming is still a widely spread phenomenon. The problems affecting the supply chain are widely ranging from poor road network and weak legal framework to lack of knowledge and capital. In this study, the development of the economy is modelled up to the year 2015 which is the dead line for the Millennium development goals. The development is modelled to take place under different assumptions of the trade and transport sectors (picture 1), which will allow comparison between the outcomes with and without improvements in trading margins. All the changes are first introduced alone in order to isolate the impact of each change, before the more realistic combined scenario is analysed.

BASE	Dynamic growth scenario without improvement in the trade and transport sectors.
TRANSPRO	Dynamic growth scenario with 10% annual improvement in productivity of the transportation sector. The productivity increase will have proportional spin-offs into other sectors, but maintenance costs will lower resources available for investment.
TRADEPRO	Dynamic growth scenario with 5% annual improvement in productivity of the trade sector. The productivity increase will have proportional spin-offs into other sectors.
TRDTRNPRO	TRANSPRO and TRADEPRO implemented simultaneously.
LESSTRA	TRANSPRO and TRADEPRO implemented simultaneously. In addition, the agricultural sector will become less dependent on trade and demands 5% less transport services annually.

Picture 1: Description of the scenarios. **Source:** Author.

In the first simulation (BASE) the economy is allowed to grow as it would without any improvements on the trade and transportation infrastructure. The base scenario replicates the basic dynamic simulation described above. This scenario will provide a useful base for comparison; as the main welfare gains of the simulations are likely to come from natural growth over time, the base results are needed to highlight the additional benefits that could be achieved by additional investment in trade.

In the second scenario (TRANSPRO) the transportation sector is assumed to become more efficient. The current condition of the Tanzanian road network is very poor even compared with the other East-African countries. The roads are scarce and where they exist, they are often in bad condition. Making the network more tense so that different markets could be more easily reached throughout the year would allow horizontal trading networks to be established between the regions and guarantee that all producers have access to the markets. Also improving the condition of the existing roads is likely to induce a substantial change as in their current condition some roads are impassable and some allow only smaller cars to pass at very low speed, which increases the cost and duration of the transport. On the whole, there is scope for substantial improvement in the effectiveness of trade. The government of Tanzania has designed the programme to induce a significant improvement in the road network in order to guarantee favourable circumstances for trade. The so-called Road Sector Development Programme sets clear objectives to infrastructure improvement in order to reach the development goals set by the Government in the 2025 Vision. The idealised programme would upgrade 90% of the trunk roads together with 70% of the regional roads over ten years. The total cost of the programme is estimated to be USD 2.5 billion excluding

the maintenance costs (Ministry of Works 2002). An alternative scenario is the desirable programme that would upgrade 60% of the trunk roads and 42% of the regional network. These improvements would be capable to support the predicted economic growth of the country in order to realise the development objectives set by the government. The cost of the desired programme is estimated at USD 1.8 billion and maintenance costs. The programme document outlines also a minimal programme that covers only the "indispensable development and maintenance works in order to avert serious hindrances to minimal growth of the national economy" (Ministry of Works 2002) at an estimated cost of USD 1.5 billion and maintenance costs. However, the financing of the programme is still pending and under current financial setup of the road sector the resources are insufficient even for the realisation of the minimal work programme. Funding the road development programme is a sizable investment both in absolute terms as well as in relation to the Tanzanian GDP. The current simulation is designed to contribute to the analysis of the potential benefits of the programme that can be compared with the estimated costs. In the simulations it is assumed that the roads are funded and built by foreign actors using foreign resources. This is in line with actual situation in the country and the design of the road sector programme where the most recent projects have been donor funded. The most successful bidders for the implementation of road projects have been Japanese firms using Japanese technology and skilled labour. Despite the resistance to the low labour intensity of the projects, the implementation has been efficient and the Tanzanian companies have so far been unable to compete with the foreign competitors. However, the Tanzanian economy still has to pay for the roads in terms of maintenance costs. This cost lowers the resources available to the economy. The maintenance costs are assumed to be financed from the public and private sector through road user fees and budget allocations to gross investment. In the model the maintenance costs are assumed to crowd out investment as part of the money is used for maintenance, and thus the net resources available for capital accumulation in the next period are lower. In the scenarios with road improvement five percent of the new investment is diverted to model the cost of maintenance amounting roughly to USD 800 million as projected in the Road Sector Development Programme (Ministry of Works 2002).

In the model, the transportation sector is assumed to get a ten percent productivity boost annually during a ten year period from year 2006 up to 2015. Even though the assumed efficiency increase in the simulations is large, considering the original state of the sector, substantial improvements are not unrealistic if only the plans for considerable road improvement are implemented. A recent study by Fan *et al.* (2005b) estimate that each shilling invested in roads in Tanzania would yield over 9 shillings in return, and thus substantial welfare gains can be expected with even modest investment.

Furthermore, the productivity increase in the model is assumed to be the same for all regions in the country. The Road Sector Development programmes have detailed plans for individual roads that are to be reconstructed, and the roads are spread throughout the country. Some areas are currently less privileged in terms of the road network and the aim of the programme is not to provide equally extensive roads for all areas, but to provide sufficient and equal access to the main markets and centres. One should also bear in mind that the improvement of trade sector in one region depends on the improvement in other regions as transportation cuts through the whole country. In absence of further information on the regional estimated efficiency improvements, it is assumed that the efficiency gain in percentage terms is the same throughout the country.

In the third simulation (TRADEPRO) the retail and wholesale trading sector is assumed to become more efficient. Currently the trade is dominated by long supply chains, lack of market information, suspicion of trading with unknown partners due to weak legal framework to enforce the contracts, corruption, and imperfect competition. However, the government has recently launched a Business Environment Strengthening for Tanzania Programme (BEST) that aims at achieving better regulation and improving commercial dispute resolution, strengthening the investment centre, changing the culture of the government and empowering civil sector advocacy. Also the interest of the farmers' unions within the country as well as e.g. the Nordic donors in the international forum has recently shifted into private sector development, and new programmes have been planned to support commercialisation and trade development. The success of the programmes is crucial to the development of the economy as despite the sizable transportation costs, trading margins present the largest price wedge throughout the supply chain. However, even though there is large scope for improvement also at this sector, the change cannot be assumed to be as easily achieved as in the transportation sector. Thus, the simulation models an annual increase of five percent in the productivity of trade sector during the years 2006-2015.

The fourth simulation (TRDTRNPRO) represents a scenario where both transportation sector and the trade sector improve as described above. The sectors are tightly linked and they use each others' products as intermediate inputs in production, and both sectors are thus likely to benefit from the productivity growth also in the other sector. Furthermore, introducing the two improvements simultaneously allows the analysis to bring about possible synergies as the price changes due to one improvement can be exploited by the other. Thus, the economic adjustment for each improvement is taking place in more favourable circumstances when implemented together than when each change takes place in isolation.

In the fifth simulation (LESSTRA) technical improvements are assumed to lead to higher production levels and lower prices for the services in the trade and transport sectors, as in the previous simulation. However, in the last simulation the improved trading environment is allowed to channel through the economy also in terms of lower cost shares that need to be spent on trade and transport. The main buyers of marketing services are the agricultural sectors that are highly dependent on trade services and they spend around 40-50 percent of their intermediate input expenditure on trade. In addition to TRDTRNPRO, the improvement in trade in LESSTRA scenario is assumed to imply that the agricultural sectors benefit from better quality and cheaper roads and trade services so that they are able use less of them. This means that the share of value added spent on trade decreases by five percent annually over the years when trade and transport sectors are improving. Over the total simulation period the dependence on trade declines decreasing the total use of intermediate inputs and increasing the relative use of other intermediate inputs. This is likely to benefit the agricultural sectors relative to other sectors as they are most dependent on trading margins.

4.2 Technical spillovers

A common characteristic of all the simulations above is the modelling of the productivity growth. As previously discussed a part of the dynamic characteristics of the model is the one percent annual growth in productivity for all sectors. This productivity growth is incorporated in the model as a reduction in the value of the constant (ava_a) in the production equation 3.1. In the simulations the transportation sector and/or the trade sector will get an additional increase in the production so that the total productivity growth will be ten percent and five percent, respectively. However, increasing the level and quality of infrastructure and trade is likely to lead not only to direct impacts on production but also indirect impacts through increased productivity of other factors. These spill-over effects are widely found in literature from different parts of the world. For example, Deichmann *et al.* (2000) found that 10 percent increase in market access in Mexico increased labour productivity by 6 percent, whereas Bisganger *et al.* (1993) estimated that improved road investment enhances agricultural output with an elasticity of about 0.2 in India. Also Felloni *et al.* (2001) showed that the road density of agricultural land has a significant and positive effect on agricultural production and on land and labour productivity in China. In other words infrastructure improvements extend over and above the direct effect on the specific sector. Thus, besides the productivity gain for individual sectors, also other sectors using their products as intermediate

inputs in production will benefit from the new improved functioning of transport and trade sector. The magnitude of the productivity boost the related sectors will get, depends on how closely related they are to the improving sector. The decision rule for allocating the productivity spill-over is to multiply the productivity growth at transport/trade sector by the value share of the intermediate input out of total production in the given sector. In other words, the productivity growth in sector *a* is calculated as presented in equation 4.1.

$$prod.growth_a = 0.01 + prod.growth_{transport/trade} \cdot \left(\frac{Intermediate_{transport/trade}}{Total\_output} \right)_a^{\alpha^{gr}} \qquad (4.1)$$

This inducement mechanism is chosen with regards to empirical evidence from the developing countries. Fan and Rao (2003) have shown that investment in road sector brings about large productivity gains to other sectors in the economy, and indeed is one of the most efficient ways to enhance growth and poverty alleviation. Also other authors have found a link between road improvement and overall growth (see e.g. Malmberg *et al.* 1997). The results indicate that lower marketing margins generate higher productivity and growth in all sectors in the society, and the inducement mechanism chosen for this study is likely to mimic the phenomenon of overall spillovers to the whole economy of better-quality roads and trade services. As the actual allocation mechanism of the benefits is not known, the spillovers are spread according to the closeness of the sectors using the information on their production technology.

5. Results

5.1 Economic Development from 2001 to 2005

Before proceeding to the analysis of the simulations, the model is run from the base year of 2001 up to 2005 without improvements in the marketing sectors. The base year for the model is the same as the year for which the SAM was constructed. The choice of the base is partially forced by the lack of more recent data but it has also two advantages. Firstly, it allows the results to be compared with the macroeconomic aggregates from the past five years to ensure that the model is correctly specified and able to replicate the economic development that is known to have happened. Secondly, the results are later on linked to the poverty status measured in a household budget survey in 2001, and thus the growth of income should be calculated from this base year.

The main economic indicator for verification is the growth of the gross domestic product (GDP). It is a summary indicator for the total performance of the economy overlooking all deviances in particular sectors. The most recent five year average of the GDP growth in Tanzania is 4.9 percent *per annum* (World Fact Book 2004) representing unusually rapid growth whereas the long run growth pattern from the last decade has been between 3-5 percent annually (Fan *et al.* 2005). The dynamic CGE model constructed here replicates, or at least gives a conservative estimate on, the growth rate as the dynamic simulation reports an average growth rate of 4.5 over the five-year period. As the base year data was constructed using the most recent data to represent the state of the economy in 2001, the comparison of the growth rates indicates that the constructed model is able to mimic the growth of the Tanzanian economy in normal circumstances. The success of the future predictions depends on the shocks faced by the economy over the years. In the model these shocks are carefully controlled and the results are limited to analyse only the imposed shocks. In real life the future shocks may differ, but based on the success of replicating the growth rates in absence of shocks, the model is likely to give a reliable indicator of the counterfactual, i.e. the state of the world if the shocks (and only the modelled shocks) face the economy.

5.2 Regional Model up to 2015

The simulation model predicts the economic performance of the Tanzanian economy until the year 2015 under five different scenarios described above. The overall growth of the economy is given by the average annual growth rate of real GDP over the whole period. The growth rate in the base scenario is four percent per year, which indicates reasonably high rate of growth but which falls behind from the government's optimistic scenarios of reaching "a growth rate of 8 percent per annum or more" (Vision 2025). However, the growth rates can be improved by making the infrastructure and/or trade sectors more efficient. The growth rate for both TRANSPRO and TRADEPRO is 4.2 indicating five percent higher growth rates compared with the base scenario. If both transport and trade sectors are improved, the total growth increases up to 4.5 percent annually, implying sizable increase in the overall growth of the economy. In the last scenario, the productivity growth will increase the GDP growth up to 5.0 percent in real terms, which implies 25% increase from the base level. Other macroeconomic indicators are presented in the table 2 below:

	BASE	TRANSPRO	TRADEPRO	TRDTRNPRO	LESSTRA
Real GDP	4.0	+0.2	+0.2	+0.5	+1.0
Total absorption	3.8	+0.2	+0.3	+0.5	+1.1
Household consumption	3.8	+0.2	+0.3	+0.5	+1.1
Total investment	3.9	+0.2	+0.3	+0.5	+1.1
Government consumption	3.7	+0.2	+0.2	+0.3	+0.7
Export	4.3	+0.3	+0.4	+0.7	+1.8
Import	3.8	+0.2	+0.2	+0.4	+1.3
Real exchange rate	0.2	(.)	(.)	(.)	-0.3

Table 2: Average annual percentage change in the macroeconomic indicators in the base, and change in growth rates relative to the base. Source: Author.

Total absorption, i.e. household and government consumption as well as total investment, grows slightly slower than the overall GDP, as the growth of exports that are calculated into the GDP exceed the growth of imports, that contribute to the absorption. The increase in the absorption is divided between household, government, and investment. This is an inbuilt characteristic of the balanced closure. The exports increase in all scenarios as the non-traded trade and transport sectors become more efficient and induce an increase in the productivity of other traded sectors. The cheaper and better-quality trading inputs increase the production in all sectors. The real exchange rate depreciates slightly due to fixed trade shares, but appreciates in the last scenario when the export oriented cash crop sector becomes substantially more efficient.

Sectoral disaggregation of the real GDP growth is presented in table 3 below. The growth in the food crop sector varies by region as the more remote producers gain the most from the reduction of the trading margins. Improving transport leads to, on average, four to six percent higher growth rates in the food crop sectors compared to the base scenario. The increase in the productiveness of transportation sector shows as higher average annual growth in the production in the isolated areas compared with the producers from other regions. The improvement in the trade sector results in equally large boost in the food crop production as the improvement in transport. Even though the trade sector improves only half as fast as the transportation sector, similar growth levels are attained due to the fact that the food sector spends, on average, 40 percent of their intermediate input expenditure on trade and thus even more modest improvement in the trade sector leads to higher rates of growth. The combined scenario adds up the benefits from the two former simulations resulting in up to eleven percent higher annual growth rates in all regions compared to the base. This is a sizable increase in the production of the agricultural sector that is the main employer and source of livelihood for the rural population. Finally, the scenario with improved trade and transport

sector and decreased demand for trade leads to highest growth rates and more pronounced regional differences. In the simulation, the producers' dependence on trade as an intermediate input decreases from 40 percent down to 30 percent by the year 2015. The food producing sectors grow on average 20-30 percent faster with improved trade and transport facilities that bring down their dependence on it compared with the base scenario. This is a sizable indicator of the benefits to the economy on enhancing trade. The most productive region grows 14 percent faster than the regions that gain less from the improvements. These changes in the transportation margins by region are large enough to cause a difference in the growth patterns of the sector.

Furthermore, improvement in the trade and transportation greatly improves the growth rates of the cash crop producing sectors and enhances their growth rates on average by over ten percent. The large growth rates of the export oriented agricultural sector after domestic trade liberalisation echoes the previous results found by the Economic and Social Research Foundation (ESRF) who argue that domestic non-tariff barriers, especially costly trade and transportation, rather than international trade barriers are the main constraints for Tanzania's export (Amani *et al.* 2003). The estimates high growth rates are also supported in the light of the sector's development in recent years: the agricultural sector including both food and cash crops has achieved as high growth rates as over five percent in 2001/02 even without improvements in trade and transport, even though heavy fluctuations depending on the weather conditions are to be expected (EIU 2004b). Furthermore, as different cash crops produced in different areas require diverse production technology, regional growth rates differ also in the base. However, the regional differences are clearly pronounced in the simulations where trade and transport are made more efficient as the dependence on these services varies greatly over the regions. The cash crop producing sector benefits also most from improvements in trade as it is the largest user of trade services in relative terms. The demand for trade services varies greatly by the crop produced, and as the cultivation of different crops is highly segmented over the regions, also the welfare gains are unequally distributed. For example, in Mtwara the majority of the cash crops produced are cashewnuts and their marketing involves extensive price negotiations, use of traders, and personal involvement of expatriate export agents. Producers in Mtwara spend over 50 percent of their intermediate demand on trade. On the whole, the cash crop producing sector grows on average 20 percent faster than the base case if both trade and transport services are improved. The more isolated areas like Mwanza and Mara benefit greatly from improved trade and transport services and decreased dependence on these sectors will lead to annual growth rates of over ten percent. The regions that are closer by (Pwani) or connected with good roads (Kilimanjaro) achieve more modest, but still high growth

rates of 7-8 percent. Several percentage point difference in the growth rates is going to change the relative status of the producers in favour of the more remote locations, which also tend to be poorer. For example, in Mwanza 30 percent of the population live below the food poverty line whereas in Kilimanjaro the percentage share is only 11 (NBS 2002c). The improvement in trade services is thus likely to lead to redistribution of economic growth and welfare between the regions. However, the net impact of the regional welfare effects also depends on the size and growth rates of the non-agricultural sectors in the region and whether there is any geographical movement or concentration of these sectors due to the changes in marketing margins. The regional distribution of non-agricultural sectors was not included in the current model due to lack of data, but it is reasonable to assume that the decrease in marketing margins that favours the remote areas would also favour the non-agricultural sectors in the area, and thus the regional impact of non-agricultural sector would reinforce the regional shifts in the agricultural production in favour of the more remote and poorer areas.

The non-agricultural sectors grow roughly at the rate of overall economy. They are less affected by the improvements in trade and transport as they are less dependent on them in the base. Trade and transport move closely together as they use each others' products as intermediate inputs in their production. The highest improvement in growth among the non-agricultural sectors is at the processed food sector that benefits from the forward linkages of the rapid growth in agriculture. Also the manufacturing sector benefits from improved trade and transport, but also from higher demand as the incomes increase.

	BASE	TRANSPRO	TRADEPRO	TRDTRNPRO	LESSTRA
Agricultural sector					
Food crops in Dodoma	3.68	+0.16	+0.20	+0.36	+0.78
Food crops in Arusha	3.69	+0.17	+0.21	+0.38	+0.93
Food crops in Kilimanjaro	3.63	+0.15	+0.20	+0.35	+0.74
Food crops in Tanga	3.66	+0.16	+0.19	+0.35	+0.76
Food crops in Morogoro	3.65	+0.16	+0.19	+0.35	+0.74
Food crops in Pwani	3.65	+0.15	+0.18	+0.34	+0.71
Food crops in Dar	3.65	+0.15	+0.18	+0.33	+0.71
Food crops in Lindi	3.72	+0.17	+0.20	+0.38	+0.92
Food crops in Manyara	3.70	+0.17	+0.21	+0.38	+0.92
Food crops in Mtwara	3.72	+0.17	+0.20	+0.38	+0.94
Food crops in Ruvuma	3.72	+0.18	+0.21	+0.39	+0.99
Food crops in Iringa	3.67	+0.16	+0.20	+0.36	+0.80
Food crops in Mbeya	3.68	+0.17	+0.20	+0.37	+0.87
Food crops in Sinyanga	3.72	+0.17	+0.20	+0.38	+0.92
Food crops in Tabora	3.72	+0.18	+0.22	+0.39	+1.01
Food crops in Rukwa	3.78	+0.19	+0.23	+0.42	+1.23
Food crops in Kigoma	3.74	+0.18	+0.22	+0.40	+1.11
Food crops in Shinyanga	3.71	+0.18	+0.22	+0.39	+0.98
Food crops in Kagera	3.78	+0.18	+0.24	+0.42	+1.29
Food crops in Mwanza	3.78	+0.20	+0.23	+0.42	+1.19
Food crops in Mara	3.79	+0.20	+0.22	+0.42	+1.20
Cash crops in Dodoma	4.92	+0.53	+0.62	+1.15	+3.21
Cash crops in Arusha	4.95	+0.52	+0.63	+1.14	+3.38
Cash crops in Kilimanjaro	4.91	+0.53	+0.65	+1.17	+3.42
Cash crops in Tanga	5.02	+0.50	+0.65	+1.13	+3.53
Cash crops in Morogoro	4.83	+0.50	+0.62	+1.12	+3.13
Cash crops in Pwani	4.68	+0.41	+0.56	+0.96	+2.50
Cash crops in Dar	4.64	+0.38	+0.52	+0.89	+2.34
Cash crops in Lindi	4.78	+0.45	+0.62	+1.06	+2.94
Cash crops in Manyara	4.88	+0.47	+0.62	+1.09	+3.23
Cash crops in Mtwara	4.82	+0.47	+0.63	+1.09	+3.09
Cash crops in Ruvuma	5.02	+0.56	+0.65	+1.20	+3.63
Cash crops in Iringa	5.05	+0.52	+0.66	+1.16	+3.72
Cash crops in Mbeya	4.95	+0.50	+0.64	+1.13	+3.46
Cash crops in Sinyanga	5.06	+0.59	+0.65	+1.23	+3.64
Cash crops in Tabora	5.20	+0.61	+0.68	+1.29	+4.13
Cash crops in Rukwa	5.37	+0.68	+0.69	+1.37	+4.56
Cash crops in Kigoma	5.09	+0.53	+0.68	+1.20	+4.03
Cash crops in Shinyanga	5.20	+0.58	+0.69	+1.27	+4.27
Cash crops in Kagera	5.17	+0.54	+0.70	+1.23	+4.39
Cash crops in Mwanza	5.35	+0.59	+0.73	+1.31	+4.96
Cash crops in Mara	5.32	+0.58	+0.72	+1.29	+4.78
Livestock/fishing/hunting	3.76	+0.18	+0.23	+0.41	+0.98
Non-agriculture					
Trade	4.08	+0.25	+0.30	+0.55	+0.09
Transport	4.30	+0.38	+0.29	+0.67	+1.17
Processed food	4.07	+0.23	+0.29	+0.52	+1.26
Manufacturing	4.16	+0.23	+0.28	+0.50	+0.89
Services	3.94	+0.19	+0.10	+0.37	+0.56
TOTAL	3.97	+0.23	+0.26	+0.49	+0.99

Table 3: Sectoral disaggregation of average annual growth of real GDP in the base, and change in growth rates relative to the base. Source: Author.

Despite the reasonably high level of growth is in the base scenario, the GDP growth slows down over time. The reason for the decreasing rate of growth rate is revealed by the disaggregated analysis of the GDP growth presented in table 4.

	2002-2005	2006-2010	2011-2015
BASE			
Total factor growth	4.3	3.9	3.6
Total productivity growth	0.1	0.0	0.0
Total GDP growth	4.5	3.9	3.6
TRANSPRO			
Total factor growth	4.3	4.2	3.7
Total productivity growth	0.1	0.3	0.0
Total GDP growth	4.5	4.5	3.7
TRADEPRO			
Total factor growth	4.3	4.3	3.8
Total productivity growth	0.1	0.2	0.0
Total GDP growth	4.5	4.5	3.8
TRDTRNPRO			
Total factor growth	4.3	4.6	3.8
Total productivity growth	0.1	0.4	0.0
Total GDP growth	4.5	5.0	3.9
LESSTRA			
Total factor growth	4.3	5.2	4.7
Total productivity growth	0.1	0.7	0.2
Total GDP growth	4.5	5.9	4.9

Table 4: Disaggregation of the GDP growth. Source: Author.

The GDP growth is caused by the growth of total factor endowment and the growth of total factor productivity. In the model, the total factor growth is declining over time causing total economic growth to slow down. Closer inspection on the factor specific growth rates reveals that even though the investment rates are able to generate high levels of new capital despite the cost of road maintenance, and the unskilled labour sector is able to supply sufficient amount of labour to meet the increased demand for labour, the skilled labour supply is lagging behind. As skilled workers are not assumed to be unemployed, the pool of skilled labour force only grows by 2.9 percent per year. However, as the skilled labour is difficult to substitute with any other factor of production, the limited supply is slowing down the overall growth rates as the factor becomes increasingly difficult to substitute. This brings about an important policy result implying that Tanzania cannot maintain the current high growth rates unless it invests in the growth of the restricting factors, such as skilled labour. Furthermore, the growing real wage of the unskilled labour diverts the demand for it over time. The formally employed unskilled labour is substituted by growing use of subsistence factor,

i.e. unofficial labour on the farms, whose wage remains unchanged. Over time, the economy balances into a steady state where the growth incurs close to the rate of the most slowly growing factor once the possibilities for substitution diminish.

As the GDP growth is mainly due to the growth of factors of production it is useful to look more closely on the growth patters on each of the factor. Table 5 below presents the average growth rates of each factor.

	BASE	TRANSPRO	TRADEPRO	TRDTRNPRO	LESSTRA
Subsistence factor	4.08	+0.21	+0.23	+0.44	+1.09
LABOUR:					
Child labour	2.60	+0.25	+0.30	+0.55	+1.74
Female labour:					
Non-educated	2.24	+0.22	+0.26	+0.48	+1.36
Not finished primary	3.11	+0.36	+0.43	+0.78	+2.36
Not finished secondary	3.12	+0.23	+0.26	+0.50	+1.31
Secondary or above	2.9	(.)	(.)	(.)	(.)
Male labour:					
Non-educated	2.56	+0.24	+0.28	+0.52	+1.48
Not finished primary	2.87	+0.29	+0.34	+0.63	+1.85
Not finished secondary	3.25	+0.25	+0.28	+0.53	+1.25
Secondary or above	2.9	(.)	(.)	(.)	(.)
CAPITAL:					
Agricultural capital	4.70	+0.12	+0.21	+0.33	+0.97
Non-agricultural capital	4.51	+0.03	+0.14	+0.16	+0.25
LAND	4.08	+0.25	+0.30	+0.55	+1.68

Table 5: Average annual percentage change of the supply of factors of production in the base and change in growth rates relative to the base. Source: Author.

Subsistence factor is growing steadily over time, substituting for unskilled labour whose wage increase slows down the demand for it. The demand for labour is still growing, and in fact if the trade and/or transport sectors are improved, the use of labour increases faster than the average population growth rate implying that the employment situation improves over the years. However, as discussed above, the growth rate of the skilled labour is fixed below the average growth rates making it a critical factor of production slowing down the potential growth. The use of workers who have not finished secondary school but have finished primary school increases as they are the closest substitutes for the increasingly scarce highly skilled labour. The capital growth rates are dictated by the savings in the economy, and thanks to high savings rates, the capital stock is growing fast. The technological change is too slow to accommodate for the rapid capital

accumulation and slow increase in its complements, which leads to the lower growth rates that would otherwise be possible.

Besides the factor supply, also wages paid to each factor influences the welfare of the households owning the factors in question. The growth rates of the factor specific wages are presented in table 6 below:

	BASE	TRANSPRO	TRADEPRO	TRDTRNPRO	LESSTRA
Subsistence factor	Fixed	Fixed	Fixed	Fixed	Fixed
Labour:					
Child labour	1.00	1.00	1.00	1.00	1.00
Female:					
Non-educated	1.00	1.00	1.00	1.00	1.00
Not finished primary	1.00	1.00	1.00	1.00	1.00
Not finished secondary	1.00	1.00	1.00	1.00	1.00
Secondary or above	1.34	1.57	1.60	1.83	2.26
Male:					
Non-educated	1.00	1.00	1.00	1.00	1.00
Not finished primary	1.00	1.00	1.00	1.00	1.00
Not finished secondary	1.00	1.00	1.00	1.00	1.00
Secondary or above	1.36	1.61	1.64	1.88	2.36
Capital:					
Agricultural capital	-0.74	-0.58	-0.64	-0.47	0.11
Non-agricultural capital	-0.80	-0.64	-0.69	-0.54	-0.21
Land	Fixed	Fixed	Fixed	Fixed	Fixed

Table 6: Percentage change in the wage rates of primary factors of production. Source: Author.

The wage of the subsistence factor and land are assumed to be fixed implying that the factor in question is currently unemployed and any quantity can be demanded at a given price. The non-educated labour force is also assumed to have a fixed wage, which however, is made to grow by one percent exogenously. As the supply of skilled labour increases slower than other labour categories, its price must rise to clear the markets. There is thus an increasing skill premium in the wages as the demand for skilled workers grows faster than the supply. This widening of the wage gap can be mediated by increased investment in education that increases the supply for skilled labour. On the other hand, the supply of capital is growing faster than the economy as a whole, making it a relatively more abundant factor, and thus the wage paid to capital both at the agricultural as well as the non-agricultural sector decreases relative to other factors. In other words, as the unskilled wage rate increases exogenously and its complement skilled labour force grows slower implying that the skilled wage must increase, then wage for capital that is complementary to labour but grows faster

must decrease relative to the other factors in order to keep the capital fully employed. Only in the last scenario the agricultural sector grows so rapidly that also agricultural capital becomes a scarce factor which bids up its price. As a policy conclusion, the wedge between the rising difference between unskilled and skilled labour and, on the other hand, labour and capital can be mediated by upgrading the skilled labour sector and making capital more substitutable with other factors of production by changing the production technology. The decrease in relative wage, however, does not imply that the factor payments to capital would decrease but only that the growth of the factor payments is slower than the growth rate of capital, as shown in table 7 below.

	BASE	TRANSPRO	TRADEPRO	TRDTRNPRO	LESSTRA
Subsistence factor	4.08	+0.21	+0.23	+0.44	+1.09
LABOUR:					
Child labour	3.62	+0.26	+0.30	+0.56	+1.75
Female labour:					
Non-educated	3.26	+0.22	+0.26	+0.48	+1.37
Not finished primary	4.14	+0.36	+0.43	+0.79	+2.38
Not finished secondary	4.15	+0.23	+0.27	+0.50	+1.32
Secondary or above	4.28	+0.23	+0.27	+0.50	+0.95
Male labour:					
Non-educated	3.58	+0.24	+0.28	+0.52	+1.50
Not finished primary	3.89	+0.29	+0.34	+0.63	+1.87
Not finished secondary	4.28	+0.25	+0.28	+0.53	+1.27
Secondary or above	4.30	+0.25	+0.29	+0.54	+1.03
CAPITAL					
Agricultural capital	3.92	+0.29	+0.32	+0.61	+1.86
Non-agricultural capital	3.68	+0.19	+0.24	+0.43	+0.86
LAND	4.08	+0.25	+0.30	+0.55	+1.68

Table 7: Average annual growth rates of factor incomes in the base and change in growth rates relative to the base. Source: Author.

How the income changes are distributed over the different household groups depends on the structure of their income sources and their ownership of the given factors of production. As presented in the table 8 below, the rural population get most of their income from subsistence farming, as was to be expected. The subsistence factor incorporates factors needed for producing home consumed goods, usually labour not employed elsewhere and land. Even though households are integrated into the local markets, the unreliable supply and prices at the markets combined with limited sources of cash income make the households largely dependent on home consumption. Also agricultural capital and land are important sources of income for the rural households. Urban households, on the other hand, are mainly depending on income from enterprises due to the factor payments to non-agricultural capital owned by these households. Even though the urban poor

receive a high proportion of their income from capital, it does not imply that they would be the main owners of capital. In fact, the urban poor receive only 8.7 percent of the total non-agricultural capital earnings but as the group of urban poor is relatively small, this contributes to a large share of their overall income. The main beneficiaries of non-agricultural capital are non-poor rural households (48.5%) and non-poor urban households (40.6%). Highly educated labour force is also mostly urban. Only well-off households gain transfers from the rest of the world, and especially for the wealthy urban dwellers these transfers form an important part of their income.

	Rural poor	**Rural non-poor**	**Urban poor**	**Urban non-poor**	**Total**
Subsistence factor	44.6	30.4	4.8	8.0	24.6
Labour:					
Child labour	0.3	0.3	0.4	0.3	0.3
Female					
Non-educated	1.7	0.9	1.2	0.4	0.9
Not finished primary	1.2	1.0	1.2	0.9	1.0
Not finished secondary	3.0	6.0	6.2	9.7	6.7
Secondary or higher	0.1	0.6	1.3	5.2	1.9
Male					
Non-educated	3.0	1.0	0.8	0.4	1.0
Not finished primary	5.0	3.3	4.0	2.7	3.4
Not finished secondary	5.0	8.5	6.1	10.6	8.6
Secondary or higher	0.7	3.0	1.8	11.5	5.1
Capital:					
Agricultural capital	20.7	10.8	3.7	1.8	9.1
Land	8.8	4.6	1.8	0.8	3.9
Enterprises	5.0	24.3	66.3	38.0	27.5
Government	0.9	0.9	0.4	0.5	0.8
Rest of the world	0.0	4.3	0.0	9.3	5.1
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 8: Share of income by source and household. Source: Author.

Finally, table 9 below summarises the information presented above and shows the final percentage changes of income by institution taking into account the changes in the supply of factors, wages, and factor ownership. Note, however, that these growth rates are for the total income for a given group of households over the whole period. The *per capita* welfare grows slower as it must be adjusted to the population growth. Furthermore, a limitation of this consumption measure is related to the structure of the model. As the model is dynamic recursive and agents adapt their expectations based on the past rather that the future, this welfare measure fails to capture the inter-temporal optimisation of consumption and savings.

	BASE	TRANSPRO	TRADEPRO	TRDTRNPRO	LESSTRA
Enterprises	3.70	+0.19	+0.24	+0.44	+0.87
Rural poor household	3.99	+0.24	+0.27	+0.51	+1.38
Rural non-poor household	3.85	+0.22	+0.25	+0.48	+1.19
Urban poor household	3.90	+0.21	+0.26	+0.47	+1.05
Urban non-poor household	3.73	+0.21	+0.25	+0.46	+1.01

Table 9: Average annual percentage change in income in the base, and change in growth rates relative to the base.

The definition of pro-poor development varies from 'development that is good for the poor' to 'development that benefits the poor more than the rich'. Based on the simulation results investing in lowering the marketing margins can be called a pro-poor policy in both senses of the word. All household groups benefit from productivity increase, but the growth rate of the income of the rural poor increases the most both in relative and absolute terms. Even though the capital stock grows fast, its price decreases limiting the income of the wealthier urban dwellers. The rural poor, on the other hand, benefit form rising employment levels as well as higher wages. On the whole, all household groups benefit from all the scenarios and there are no substantial differences in the growth rates of their income. As the model only accommodated four household types, detailed changes in the distribution of income cannot be captured by the results.

Furthermore, changing factor demand, wages, prices, and sold quantities can have different effect on households' welfare. As an aggregated summary indicator of all the changes in the economic wellbeing of each household group, the annual change in equivalent variation (EV) is calculated in table 10. Overall, all household groups benefit from the policy, and especially the rural poor seem to benefit from economic growth and the improvement in trading and infrastructure.

	BASE	TRANSPRO	TRADEPRO	TRDTRNPRO	LESSTRA
Rural poor household	5.2	+0.4	+0.5	+0.9	+2.5
Rural non-poor household	5.0	+0.3	+0.4	+0.8	+2.0
Urban poor household	5.1	+0.3	+0.4	+0.8	+1.7
Urban non-poor household	4.9	+0.3	+0.4	+0.7	+1.6

Table 10: Annual growth rates of equivalent variation by household group in the base, and change in growth rates relative to the base. Source: Author.

5.3 Modelling Commercialisation

After analysing the regional differences between the producers, the focus is now turned into analysing the development of commercialisation. As discussed in the data section, an alternative specification of the SAM was constructed where the producers were not allocated according to their region but whether they produced for subsistence or for commercial use. When the economy grows,

the households are likely to move from subsistence production into commercialised production and take advantage of the market opportunities provided. In the previous section all production was assumed to be commercial, whereas in the following analysis subsistence producers are separated from the total production. One national commercial and one national subsistence producer is producing each of the agricultural goods. The commercial producers use intermediate inputs and different primary factors in their production whereas the subsistence farmer only uses subsistence factor. Still, as the starting point for the different aggregation is the same SAM as in the regional analysis above, also the macroeconomic results are very similar. The GDP growth rates of the simulations are presented below in table 11. Also other macroeconomic indicators are in line with the previously presented figures, which prove the assumption that the model at hand is indeed a projection of the same economy that allows us to concentrate on different aspects of the development.

Model/Scenario	**BASE**	**TRANSPRO**	**TRADEPRO**	**TRDTRNPRO**	**LESSTRA**
Regional model	3.97	+0.23	+0.26	+0.49	+0.99
Subsistence model	3.96	+0.23	+0.26	+0.48	+0.94

Table 11: Comparison of the GDP growth rates across the models in the base and change in growth rates relative to the base. Source: Author.

However, as the activity accounts are different, so are the growth rates of the specific activities. Table 12 presents the sectorally disaggregated GDP growth rates. As previously discussed, the agricultural sector grows fast in all scenarios. However, the new insight from the current model is the shift from subsistence production towards commercial production. Even though all agricultural activities grow, the commercial activities gain from the decrease in their input costs when the trade and transport sectors become more efficient. This shifts the production of commercial goods and as the commercial sector grows faster than the subsistence sector, the relative importance of the sectors also shifts in favour of commercialisation. Also the forward linkages of growth are more pronounced as the commercial food processing is growing much faster than the processing done at home. The commercial sector is able to benefit from cheaper intermediate inputs for its production and additionally take advantage of lower trade and transport costs.

	BASE	TRANSPRO	TRADEPRO	TRDTRNPRO	LESSTRA
Agricultural goods:					
Subsistence food crops	3.78	+0.17	+0.18	+0.35	+0.70
Commercial food crops	3.63	+0.17	+0.23	+0.40	+1.08
Subsistence cash crops	4.97	+0.48	+0.58	+1.05	+2.73
Commercial cash crops	4.98	+0.53	+0.66	+1.18	+3.51
Subsistence livestock	3.94	+0.20	+0.21	+0.42	+0.93
Commercial livestock	3.69	+0.18	+0.23	+0.41	+0.93
Subsistence processed food	3.86	+0.23	+0.25	+0.48	+1.08
Commercial processed food	4.06	+0.23	+0.29	+0.52	+1.21
Non-agricultural sectors:					
Trade	4.04	+0.25	+0.30	+0.54	+0.01
Transportation	4.28	+0.38	+0.29	+0.66	+1.09
Manufacturing	4.15	+0.23	+0.27	+0.50	+0.84
Services	3.93	+0.18	+0.19	+0.37	+0.54
TOTAL	3.96	+0.23	+0.26	+0.48	+0.94

Table 12: Sectorally disaggregated GDP in the base and change in growth rates relative to the base. Source: Author.

There is also a difference between the growth rates of the primary factors of production (table 13). Compared to the previous model, the skilled labour force growth rates remain at the same national level, but the demand for subsistence factor is lower as the production shifts from subsistence to the formal sector. The released resources from the subsistence factor show in the increased demand for unskilled labour in the formal sector, and thus the workers from the domestic farms are drawn into formal employment and into the region of increasing real wages. As above, the capital growth is shifted in favour of agricultural capital that is needed to support the expansion of the commercial agricultural sector.

	BASE	TRANSPRO	TRADEPRO	TRDTRNPRO	LESSTRA
Subsistence factor	3.92	+0.20	+0.21	+0.41	+0.86
LABOUR:					
Child labour	3.08	+0.24	+0.29	+0.53	+1.59
Female labour:					
Non-educated	2.95	+0.22	+0.26	+0.47	+1.42
Not finished primary	3.51	+0.36	+0.42	+0.78	+2.45
Not finished secondary	3.12	+0.23	+0.27	+0.49	+1.34
Secondary or above	2.9	(.)	(.)	(.)	(.)
Male labour:					
Non-educated	3.05	+0.24	+0.28	+0.51	+1.48
Not finished primary	3.26	+0.28	+0.34	+0.62	+1.85
Not finished secondary	3.23	+0.24	+0.28	+0.52	+1.22
Secondary or above	2.9	(.)	(.)	(.)	(.)
CAPITAL					
Agricultural capital	4.73	+0.12	+0.21	+0.33	+1.03
Non-agricultural capital	4.50	+0.03	+0.13	+0.16	+0.21
LAND	4.07	+0.25	+0.30	+0.55	+1.73

Table 13: Average annual growth of factor demand in the base, and change in growth rates relative to the base. Source: Author.

5.4 Welfare Analysis – Will Tanzania Reach the Millennium Development Goals?

The Millennium Development Goals (MDGs) were set by the international community to half the number of people living in poverty by the year 2015. In 1991, the percentage of people living below the basic needs poverty line in Tanzania was estimated to be at 48.4 percent (UNDP 2001). The target levels of poverty in the MDG initiative were set to half the poverty from the estimated 1995 levels, and the official target for Tanzania is to lower the percentage of people living under basic needs poverty line to 24.2 percent (UNDP 2001). When the poverty indicators were re-calculated based on the 2000/2001 household budget survey, significant progress had already been achieved. The percentage of people under basic needs poverty line had dropped to 35.7 percent (NBS 2002c)[8]. According to the UNDP progress report, Tanzania is 'potentially' able to reach the goals set for it, but to do so "Tanzania's economy would need to grow by 3.8 to 4.8% a year. This rate is substantially higher than has been achieved on average over the past decades" (UNDP 2001). In addition to overall growth, the benefits should be extended to reach the poor. The report identifies insufficient access to key resources, such as markets, market information, and roads as one of the key challenges for achieving pro-poor growth. Consequently, road building is mentioned as one of the main priorities for development assistance.

[8] The food poverty line for 2001 is 5295 shillings and basic poverty line 7253 shillings per adult equivalent over 28 days.

The results of the current study confirm the estimates of the required GDP growth to reach the MDGs, and establish the pro-poor impact of guaranteeing good trading environment and sufficient infrastructure. Using the above presented welfare results and adjusting them for the population growth, the expected changes in *per capita* poverty measures by the year 2015 can be calculated by linking the results to the household budget survey data. Here the annual *per capita* percentage change in real income assuming 2.9% growth in population is imposed on each household in each household group in the survey. These higher estimates of future income are then compared with the poverty line, and new estimates of the population living in poverty are calculated. It is acknowledged, that the distribution of the welfare gains in real life is not likely to be equal as assumed in the calculation. However, the aggregate macro-level estimate of the poverty change is likely to be a reasonable approximation of the overall gain, even though the micro-level estimates might be biased due to limitations in the distributional data within each household group. The projected percentages of people living in poverty in 2015 are presented in figure 3.

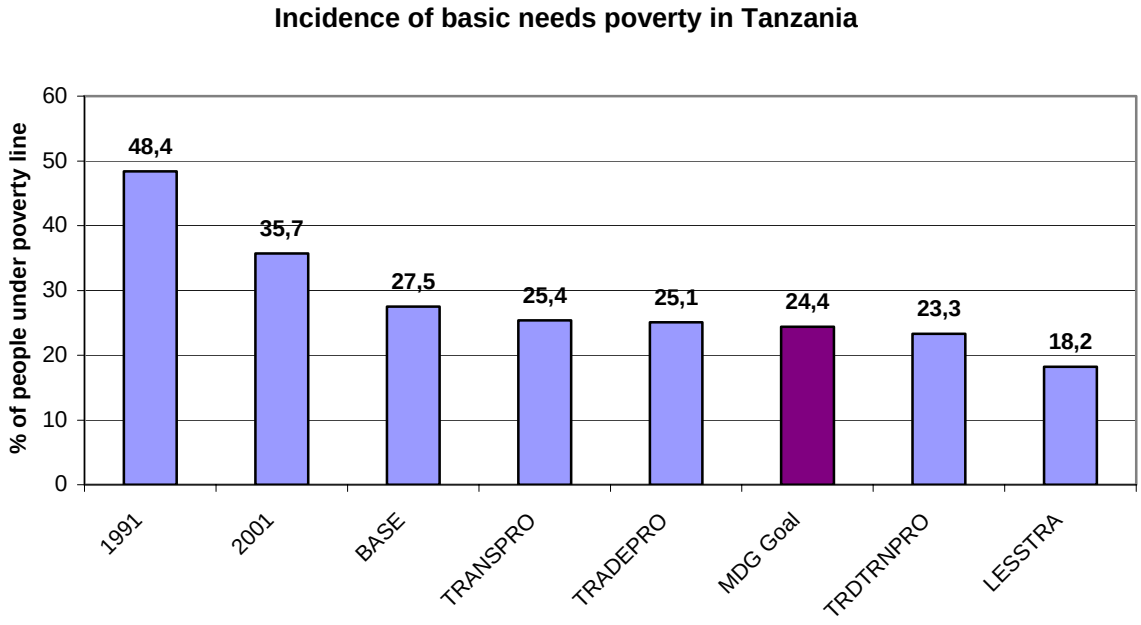

Figure 3: Incidence of poverty under different scenarios. Source: Author.

The economic growth in Tanzania has been relatively rapid and thus over the 1990's the poverty levels have fallen substantially. The simulations predict a future along a similar trend and thus the poverty levels are likely to decrease substantially in the country due to overall expansion of the economy. In the base scenario, the incidence of poverty is expected to fall down to 27.5%. However, roughly 40% higher poverty reduction rate would be required to reach the desired Millennium Development Goal of 24.4%. Creating a more favourable trading environment by

investing in infrastructure or facilitating the supply chain are both desirable policy interventions and help to decrease poverty even further. Neither one of these interventions, however, is sufficient in isolation, which highlights the fact that they are important complements for efficient trading. When both trade and transport sectors are improved, the Millennium Development Goals are likely to be reached by 2015. Finally, if the realistic assumption that less trading inputs are needed as their quality improve and supply chains get shorter is allowed, the poverty levels fall well below the set minimum target down to 18.2 percent. This predicted poverty reduction due to investment in trade and transportation is large, but in line with other estimates of welfare impact of infrastructure improvement in Tanzania. Fan *et al.* (2005b) estimate, that every million shillings (roughly USD 1000) could raise 27 people out of poverty. The desirable road improvement programme was estimated to cost USD 1.8 billion that would be enough to lift all Tanzanians from poverty assuming linear relationship between poverty reduction and investment.

The modelled scenarios with steep reduction in poverty give basis for optimism for the future development in Tanzania. However, one should be somewhat cautious when interpreting the absolute figures. As Fan *et al.* (2005) suggest the link between the official growth figures and poverty reduction is not always straightforward. Even though the economy can boast with high levels of growth, the structure of the growth and the distribution of wealth have not been favourable to the poorest population groups in the country during the recent past. A careful interpretation of the results shown is thus encouraged as the current model is unable to capture the subtle mechanisms of wealth distribution such as corruption, mismanagement of the investments, unequal regional allocation of the new investment, and political power, which all may play a part in how the increased welfare is used and allocated. However, the predicted reduction in poverty is large, and even though some of the impact may be washed away by sub-optimal behaviour, the qualitative results of a large decrease in poverty if the trade and transport sectors are enhanced still hold.

6. Conclusions

Insufficient infrastructure and cumbersome trade arrangements are costly for the Tanzanian economy in terms of higher prices, wasted resources, and unrealised potential of alleviating poverty. The results of this study highlight the magnitude of the welfare gain that could be achieved if trading margins could be lowered. Indeed, the advocated improvements are crucial for achieving the Millennium Development Goals. Enhanced marketing especially in the agricultural sector has large potential in enhancing the overall growth of the economy and the wellbeing of the households. Investing in physical infrastructure and improving the trading environment have very similar effects

on the economic growth. As both transport and trade form a wedge between the consumer and producers price, when the wedge is diminished the welfare gain is similar no matter how the change came about. The largest gains, however, are only attained when both changes are done simultaneously, and when the commercial sectors become less dependent on trading services which currently account for up to over 50 percent of their intermediate input costs. This welfare gain is more pronounced in the remote and often also poorer areas, which is likely to have implications to the regional income inequality in the country. Furthermore, improving trading services will also shift the production from subsistence into commercial production; help in the long term growth of diversifying the economy by transferring resources into processed and service sectors; and lead to higher levels of overall growth.

Still, the welfare improvements are caused by higher economic growth. The economy cannot grow 'ex nihilo' but it needs increased levels of production factors and/or productivity growth. The level of scarce factors can slow down the currently high growth levels. Especially the supply of highly skilled workers is likely to be insufficient in the future to respond to the needs of the growing economy, which will lead to higher wages to educated workers and larger wage gaps between the factors. Unless the growth of all the factors is guaranteed or the technical change allowing factors to be substituted with each other is facilitated, the government of Tanzania cannot rely on maintaining the current level of growth, not to mention achieving even higher levels of growth needed to meet the ambitious development targets.

The results in this study have strong policy implications in favour of implementing the planned road development and private sector development programmes that turn out to be welfare increasing and truly pro-poor policy choices. However, even though the Tanzanian economy is able to bear the cost of road maintenance, initial investment in the desirable scenario of road construction costs almost 10 percent of the GDP in the country. It would be unreasonable to assume that such funds could be mobilised from domestic sources in a short period of time, and the funding of the project is designed to come mainly from the donor community. If the government in collaboration with the international community prioritises infrastructure as a key to faster growth and necessary prerequisite for realising the potential of the agricultural sector, the investment is likely to pay itself back shortly. Improving the trading environment and infrastructure are important policies to implement if true poverty reduction and the Millennium Development Goals are to be achieved.

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Appendix 1A: Production shares and transportation costs by crop and region (food crops)

	Maize	Paddy	Sorghum	Wheat	Beans	Cassava	Cereals (a	Oil seeds (b	Roots (c	Other fruits (d	Other crops (e
Dodoma	1,78%	0,29%	11,49%		0,22%	3,58%	30,54%	10,27%	1,30%	0,00%	0,97%
Arusha	1,75%	0,42%	0,35%	23,96%	2,87%	0,09%	0,00%		0,45%	3,25%	1,40%
Kilimanjaro	1,97%	4,28%	0,95%	9,71%	2,85%	1,40%		0,51%	0,63%	29,54%	6,64%
Tanga	7,52%	1,62%	0,00%	0,08%	14,16%	6,99%		0,04%	0,57%	4,78%	3,07%
Morogoro	11,61%	20,07%	11,18%		6,15%	10,78%			5,37%	2,39%	1,70%
Pwani	0,77%	0,62%	0,00%		0,00%				0,83%	0,00%	4,12%
Dar	0,06%	0,16%			0,00%	1,48%			2,80%	0,05%	0,49%
Lindi	0,40%	0,45%	2,66%		0,00%	2,37%		0,45%			6,58%
Manyara*	4,31%	2,75%	3,08%	17,75%	14,82%	0,05%	3,06%	0,27%	0,38%	0,12%	1,40%
Mtwara	0,31%	0,98%	2,01%		0,00%	12,04%			0,00%		14,48%
Ruvuma	6,02%	4,89%	0,09%		3,25%	4,17%	3,43%	2,06%	1,20%		15,98%
Iringa	8,83%	0,62%	0,67%	44,37%	7,87%	2,24%	1,85%	3,10%	0,76%	0,37%	4,80%
Mbeya	17,34%	20,07%	4,05%	2,88%	11,16%	5,70%	5,96%	0,01%	4,75%	16,90%	9,71%
Singida	3,89%	0,11%	17,77%		1,49%	5,97%	29,43%	3,98%	2,28%		0,87%
Tabora	3,27%	3,75%	2,71%			3,90%		27,55%	4,39%		2,59%
Rukwa	9,58%	5,06%	3,32%	1,25%	9,34%	7,63%	9,28%	6,74%	8,89%	0,00%	0,64%
Kigoma	4,82%	3,02%	1,89%		15,15%	8,74%		3,21%	23,60%	15,45%	2,41%
Shinyanga	3,40%	9,91%	6,54%		7,72%	3,78%	2,00%	31,28%	16,60%		4,98%
Kagera	3,66%	1,10%	0,93%		2,08%	4,44%	4,85%	3,21%	7,03%	26,14%	14,01%
Mwanza	6,99%	18,75%	19,66%			11,43%	6,75%	6,74%	15,25%	0,00%	2,44%
Mara	1,72%	1,09%	10,65%		0,86%	3,23%	2,85%	0,57%	2,94%	1,00%	0,74%

Production in ‘000 tonnes by region in 2002/2003. Source: Statistics Unit, Ministry of Agriculture and Food Security.

a) The production of other cereals has been estimated using the production of millet
b) The production of oil seeds has been estimated using the production of groundnuts
c) The production of roots has been estimated using the production of sweet potato
d) The production of other fruits and vegetables has been estimated using the production of bananas
e) Calculations made based on cultivated area, as total production was not reported. Figures are for 1998/1999. As Manyara region did not readily exist, Arusha's share is split equally between Arusha and Manyara. Source: District Integrated Agricultural Survey 1998/99 - National Report, Statistics Unit, Ministry of Agriculture and Cooperatives, Dar es Salaam, February 2001.

Appendix 1B: Production shares and transportation costs by crop and region (cash crops)

	Cotton (a	Coffee (b	Tobacco (c	Tea (d	Cashew (e	Sisal (f	Sugar (g	Transport cost (g
Dodoma			0,05%					250
Arusha	0,00%	3,06%	2,87%			2,06%		450
Kilimanjaro	0,01%	9,70%				2,58%	29,91%	300
Tanga	0,03%	0,76%	0,03%	20,67%	0,92%	82,47%		200
Morogoro	0,18%		0,95%			9,27%	68,38%	150
Pwani	0,05%		0,10%		10,51%	3,61%		80
Dar					1,95%			0
Lindi			0,13%		20,60%			600
Manyara*	0,06%	0,47%						500
Mtwara					60,93%			800
Ruvuma		16,99%	27,71%		5,10%			700
Iringa	0,05%	0,45%	1,71%	67,96%				200
Mbeya	0,00%	22,08%	4,11%	10,37%				450
Singida	0,00%		2,58%					500
Tabora	6,06%		19,99%					800
Rukwa			2,65%					1300
Kigoma	0,15%	1,38%	0,13%					1200
Shinyanga	63,29%		36,56%					800
Kagera	0,86%	43,54%	0,28%	1,00%			1,71%	1600
Mwanza	23,21%		0,09%					1200
Mara	6,04%	1,58%	0,08%					1300

a) Cotton (seed cotton) Production by Region (in '000' tonnes) in 2002/2003. Source: Tanzania Cotton Board.
b) Coffee Production by Region (in '000' tonnes) in 2002/2003. Source: Tanzania Coffee Board.
c) Calculations made based on cultivated area, as total production was not reported. Figures are for 1998/1999. Source: District Integrated Agricultural Survey 1998/99 - National Report, Statistics Unit, Ministry of Agriculture and Cooperatives, Dar es Salaam, February 2001.
d) Tea (Made Tea) Production by Region (in '000' Tonnes) in 2002/2003. Source: Tanzania Tea Authority.
e) Cashewnuts (Raw) Production by Region (in '000' Tonnes) in 2002/2003. Source: Tanzania Cashewnut Board.
f) Sisal production by region (in '000 tonnes) in 2000. Source: Tanzanian Sisal Authority.
g) Source: Tarimo & Takamura (1998) Sugarcane production, processing, and marketing in Tanzania, African study Monographs, 19(1): 1-11, May 1998.
h) in 000 TSh. Source: Own interviews with local transporters and producers in March-April 2005.

Appendix 2: SAM Accounts

ACTIVITIES

1) Regional model

Agricultural Activities

AFOODDOD	Growing of food crops in Dodoma
AFOODARU	Growing of food crops in Arusha
AFOODKIL	Growing of food crops in Kilimanjaro
AFOODTAN	Growing of food crops in Tanga
AFOODMOR	Growing of food crops in Morogoro
AFOODPWA	Growing of food crops in Pwani
AFOODDAR	Growing of food crops in Dar es Salaam
AFOODLIN	Growing of food crops in Lindi
AFOODMAN	Growing of food crops in Manyara
AFOODMTW	Growing of food crops in Mtwara
AFOODRUV	Growing of food crops in Ruvuma
AFOODIRI	Growing of food crops in Iringa
AFOODMBE	Growing of food crops in Mbeya
AFOODSIN	Growing of food crops in Singida
AFOODTAB	Growing of food crops in Tabora
AFOODRUK	Growing of food crops in Rukwa
AFOODKIG	Growing of food crops in Kigoma
AFOODSHI	Growing of food crops in Shinyanga
AFOODKAG	Growing of food crops in Kagera
AFOODMWA	Growing of food crops in Mwanza
AFOODMAR	Growing of food crops in Mara
ACASHDOD	Growing of cash crops in Dodoma
ACASHARU	Growing of cash crops in Arusha
ACASHKIL	Growing of cash crops in Kilimanjaro
ACASHTAN	Growing of cash crops in Tanga
ACASHMOR	Growing of cash crops in Morogoro
ACASHPWA	Growing of cash crops in Pwani
ACASHDAR	Growing of cash crops in Dar es Salaam
ACASHLIN	Growing of cash crops in Lindi
ACASHMAN	Growing of cash crops in Manyara
ACASHMTW	Growing of cash crops in Mtwara
ACASHRUV	Growing of cash crops in Ruvuma
ACASHIRI	Growing of cash crops in Iringa
ACASHMBE	Growing of cash crops in Mbeya
ACASHSIN	Growing of cash crops in Singida
ACASHTAB	Growing of cash crops in Tabora
ACASHRUK	Growing of cash crops in Rukwa
ACASHKIG	Growing of cash crops in Kigoma
ACASHSHI	Growing of cash crops in Shinyanga
ACASHKAG	Growing of cash crops in Kagera
ACASHMWA	Growing of cash crops in Mwanza
ACASHMAR	Growing of cash crops in Mara
ALIFIHU	Poultry & livestock -Fishing & fish farms-Hunting & forestry

Non-Agricultural Activities

APROCE	Processed food and beverages (including meat and dairy, grain milling)
AMANUF	Manufacturing sector
ASERVI	Services sector
ATRADE	Wholesale and retail trade
ATRANS	Transport and communication

2) Commercialisation Model

Agricultural Activities

AFOODSUB	Activity producing subsistence food crops
AFOODCOM	Activity producing commercial food crops
ACASHSUB	Activity producing subsistence cash crops
ACASHCOM	Activity producing commercial cash crops
ALIFIHUSUB	Livestock -Fishing-Hunting & forestry for subsistence
ALIFIHUCOM	Livestock -Fishing-Hunting & forestry for marketing

Non-Agricultural Activities

APROCESUB	Processed food and beverages for subsistence
APROCECOM	Processed food and beverages for marketing
AMANUF	Manufacturing sector
ASERVI	Services sector
ATRADE	Wholesale and retail trade
ATRANS	Transport and communication

COMMODITIES

Agricultural Commodities

CFOOD	Food crop commodity
CCASH	Cash crop commodity
CLIFIHU	Poultry & livestock -Fishing & fish farms-Hunting & forestry

Non-Agricultural Commodities

CTRADE	Wholesale and retail trade
CTRANS	Transport and communication
CPROCE	Processed food and beverages (including meat and dairy, grain milling)
CMANUF	Manufacturing sector
CSERVI	Services sector

FACTORS OF PODUCTION

FSUB	Subsistence factor

Labour

LCHILD	Child labour (age 10 to 14)
LNONF	Female labour (no formal education)
LNFPF	Female labour (not finished primary school)
LNFSF	Female labour (not finished secondary school)
LSECF	Female labour (secondary or higher education)
LNONM	Male labour (no formal education)

LNFPM	Male labour (not finished primary school)
LNFSM	Male labour (not finished secondary school)
MSECM	Male labour (secondary or higher education)

Capital

CAPAG	Agricultural capital
CAPNAG	Non-agricultural capital

Land

LAND	Agricultural land

INSTITUTIONS

Households

RURHHP	Rural household poor
RURHHNP	Rural household non-poor
URBHHP	Urban household poor
URBHHNP	Urban household non-poor

Others

ENTR	Enterprises
GOV	Government
ROW	Rest of the world

APPENDIX 3A: Social accounting matrix for regional production in Tanzania in 2001

	AFOODDOD	AFOODARU	AFOODKIL	AFOODTAN	AFOODMOR	AFOODPWA	AFOODDAR	AFOODLIN	AFOODMAN	AFOODMTW	AFOODRUV	AFOODIRI	AFOODMBE	AFOODSIN	AFOODTAB	AFOODRUK	AFOODKIG	AFOODSHI	AFOODKAG	AFOODMWA	AFOODMAR	ACASHDOD	ACASHARU	ACASHKIL	ACASHTAN	ACASHMOR	ACASHPWA	ACASHDAR
AFOODDOD																												
AFOODARU																												
AFOODKIL																												
AFOODTAN																												
AFOODMOR																												
AFOODPWA																												
AFOODDAR																												
AFOODLIN																												
AFOODMAN																												
AFOODMTW																												
AFOODRUV																												
AFOODIRI																												
AFOODMBE																												
AFOODSIN																												
AFOODTAB																												
AFOODRUK																												
AFOODKIG																												
AFOODSHI																												
AFOODKAG																												
AFOODMWA																												
AFOODMAR																												
ACASHDOD																												
ACASHARU																												
ACASHKIL																												
ACASHTAN																												
ACASHMOR																												
ACASHPWA																												
ACASHDAR																												
ACASHLIN																												
ACASHMAN																												
ACASHMTW																												
ACASHRUV																												
ACASHIRI																												
ACASHMBE																												
ACASHSIN																												
ACASHTAB																												
ACASHRUK																												
ACASHKIG																												
ACASHSHI																												
ACASHKAG																												
ACASHMWA																												
ACASHMAR																												
ALIFIHU																												
ATRADE																												
ATRANS																												
APROCE																												
AMANUF																												
ASERVI																												
CFOOD	3,314	2,771	9,308	9,646	26,775	1,03	0,428	0,831	9,052	1,602	8,825	8,026	32,391	4,225	7,634	13,404	13,097	16,764	7,398	23,113	2,816							
CCASH																						0,004	0,421	9,194	2,734	20,388	0,236	0,023
CLIFIHU	0,003	0,058	0,509	0,088	0,045	0,012	0,002	0,019	0,006	0,042	0,046	0,02	0,308	0,003	0,007	0,002	0,263	0,014	0,474	0,007	0,019		0,248	0,787	0,062			
CTRADE	1,856	3,537	7,307	3,041	4,133	0,11		0,947	6,003	2,166	7,823	3,686	19,386	4,923	8,562	23,243	26,109	13,944	36,508	27,099	6,84	0,003	0,617	6,983	3,468	7,485	0,135	
CTRANS	0,284	0,384	0,584	0,323	0,727	0,017		0,195	0,84	0,317	1,114	0,445	2,602	0,876	1,034	3,06	2,278	1,993	2,562	5,402	1,407	0,001	0,183	1,916	0,576	2,154	0,018	
CPROCE																												
CMANUF	2,979	1,565	2,799	1,073	4,71	0,259	0,047	0,679	2,172	0,927	1,644	3,117	5,367	3,827	1,385	2,156	1,908	2,964	2,363	5,679	1,875	0,005	0,59	1,193	3,449	1,096	0,641	0,099
CSERVI	0,133	0,111	0,221	0,163	0,283	0,018	0,005	0,025	0,16	0,04	0,139	0,272	0,439	0,153	0,166	0,219	0,218	0,245	0,22	0,256	0,066	2,13E-04	0,103	0,68	3,235	1,45	0,137	0,005
FSUB	26,7	18,601	78,966	66,739	105,429	5,996	4,301	8,941	35,229	22,301	46,794	57,05	157,766	43,851	37,819	77,394	95,189	58,931	89,013	88,129	25,461		0,148	1,016	0,104	1,251		
LCHILD	0,192	0,159	1,201	0,317	0,452	0,047	0,036	0,067	0,1	0,134	0,239	0,192	1,078	0,212	0,311	0,311	0,931	0,514	1,217	0,482	0,148			2,49E-04	0,008	0,004	0,083	0,015
LNONF	1,63	0,686	2,619	2,511	3,928	0,179	0,102	0,278	1,938	0,461	1,617	2,043	5,691	2,043	1,958	3,025	3,606	3,398	2,812	3,557	1,003	5,69E-04	0,078	0,13	0,349	0,047	0,269	0,047
LNFPF	0,676	0,481	2,072	1,707	2,891	0,12	0,075	0,109	1,257	0,208	1,094	1,299	4,289	0,867	1,134	1,983	2,572	2,148	2,036	2,382	0,475	4,66E-04	0,049	9,929	0,011	22,55	0,057	0,01
LNFSF	5,82	5,147	29,404	15,03	23,724	1,206	0,681	1,298	10,004	2,471	9,46	10,024	40,968	6,752	10,4	15,416	27,356	19,5	28,045	19,705	4,173	0,003	0,446	0,86	0,146	0,068	0,868	0,159
LSECF	0,011	0,063	0,5	0,127	0,144	0,007	0,002	0,007	0,048	0,016	0,047	0,045	0,403	0,018	0,022	0,058	0,297	0,058	0,444	0,082	0,026	4,53E-05	0,003		2,72E-05	8,61E-04	9,06E-05	
LNONM	0,863	0,485	3,032	1,291	1,988	0,155	0,037	0,261	0,735	0,504	1,034	0,946	3,706	0,966	1,175	1,282	2,229	1,752	3,013	1,756	0,512	6,88E-04	0,101	0,156	0,852	0,106	0,492	0,084
LNFPM	2,08	1,273	7,261	3,815	7,277	0,455	0,259	0,584	2,502	1,24	3,172	2,785	11,417	2,239	3,797	4,594	7,201	6,599	7,295	6,748	1,314	0,002	0,295	8,719	2,898	18,871	1,043	0,187
LNFSM	2,032	3,48	10,309	4,117	8,762	0,398	0,231	0,456	4,029	0,892	3,079	6,408	14,034	2,359	3,479	4,865	8,087	6,371	8,85	7,83	1,505	0,003	0,46	0,892	1,169	0,176	1,463	0,262
LSECM	0,106	0,119	0,793	0,319	0,711	0,031	0,015	0,033	0,187	0,076	0,239	0,193	1,122	0,136	0,204	0,337	0,61	0,409	0,711	0,596	0,102	4,59E-04	0,042	0,042	0,189	0,03	0,009	
CAPAG	9,13	7,855	37,388	19,137	32,636	1,713	0,977	2,094	13,824	4,093	13,139	15,753	53,947	10,465	15,125	20,998	34,958	27,452	35,658	28,58	6,154	0,007	1,021	14,013	3,93	28,204	2,978	0,532
CAPNAG																												
LAND	3,912	3,364	16,013	8,196	13,978	0,734	0,419	0,897	5,922	1,754	5,628	6,747	23,104	4,483	6,48	8,994	14,974	11,761	15,272	12,242	2,636	0,003	0,438	6,004	1,684	12,085	1,276	0,228
ENTR																												
RURHHP																												
RURHHNP																												
URBHHP																												
URBHHNP																												
GOV																												
ROW																												
S-I																												
DIRTAX																												
IMPTAX																												
VATAX	0,051	0,036	0,12	0,104	0,231	0,011	0,004	0,013	0,079	0,021	0,087	0,104	0,312	0,076	0,066	0,135	0,132	0,122	0,116	0,196	0,042	6,71E-05	0,009	0,242	0,053	0,525	0,013	0,002
INDTAX																												
FACTAX																												
TOTAL	61,772	50,175	210,406	137,744	238,824	12,498	7,621	17,734	94,087	39,265	105,22	119,155	378,33	88,474	100,758	181,476	242,015	174,939	244,007	233,841	56,574	0,033507034	5,252	62,7562494	24,9170272	116,4908612	9,718090649	1,653

ACASHLIN	ACASHMAN	ACASHMTW	ACASHRUV	ACASHIRI	ACASHMBE	ACASHSIN	ACASHTAB	ACASHRUK	ACASHKIG	ACASHSHI	ACASHKAG	ACASHMWA	ACASHMAR	ALIFIHU	ATRADE	ATRANS	APROCE	AMANUF	ASERVI	CFOOD	CCASH	CLIFIHU	CTRADE	CTRANS	CPROCE	CMANUF	CSERVI	FSUB	LCHILD	LNONF	LNFPF
																				36,8											
																				33,413											
																				139,3											
																				78,133											
																				143,338											
																				7,002											
																				3,647											
																				9,421											
																				61,606											
																				18,878											
																				62,906											
																				68,421											
																				236,571											
																				48,473											
																				65,495											
																				111,785											
																				155,112											
																				118,583											
																				163,903											
																				152,399											
																				33,299											
																					0,034										
																					5,144										
																					61,746										
																					24,844										
																					114,96										
																					9,717										
																					1,654										
																					19,218										
																					0,454										
																					58,152										
																					42,701										
																					29,614										
																					27,066										
																					1,957										
																					23,251										
																					2,681										
																					1,669										
																					95,851										
																					54,056										
																					27,49										
																					9,045										
																						774,899									
																							1013,362								
																								498,667							
																									1531,067						
																										2027,651					
																											4265,704				
														28,14			605,402	0,153	51,045												
0,255	0,019	0,72	3,097	1,33	1,344	0,225	1,89	0,231	0,066	4,733	2,158	0,576	0,213				214,625	79,975	0,255												
	0,038		1,379	0,037	1,792				0,112		3,532		0,128	14,62			120,364	25,721	35,797												
1,492	0,052	5,82	6,599	5,336	3,955	0,27	5,009	0,721	0,389	23,485	15,513	9,575	3,08	55,539	12,858	10,404	115,663	163,927	120,074												
0,179	0,006	0,671	2,36	0,825	0,656	0,139	1,985	0,371	0,058	5,906	2,091	1,53	0,478	7,884	73,356	17,959	11,556	39,45	101,745												
														2,096			39,484	0,099	33,242												
1,059	0,051	3,092	4,426	4,563	2,902	0,257	3,164	0,264	0,156	15,893	3,884	4,502	1,308	19,946	17,367	38,047	49,874	654,719	390,194												
0,055	0,005	0,161	0,293	2,489	0,606	0,011	0,118	0,011	0,015	0,497	0,487	0,126	0,048	7,594	114,86	27,182	28,551	135,594	2618,947												
	0,023		0,821	0,242	1,1				0,067		2,137		0,076	231,284			187,377		372,715												
0,16	0,001	0,473	0,04	0,001			0,151		0,004	1,579	0,021	0,579	0,151	9,792	0,129		0,159	1,147	0,26												
0,498	0,006	1,469	0,648	0,025	0,319	0,029	0,259	0,03	0,019	0,746	0,545	0,122	0,052	12,047	0,938		0,6	2,216	3,183												
0,109	0,004	0,319	0,407	0,02	0,197	0,024	0,277	0,025	0,013	1,283	0,892	0,347	0,102	2,447	1,907		1,94	1,804	6,411												
1,691	0,045	4,978	3,606	0,147	2,205	0,157	1,569	0,161	0,139	5,914	3,922	1,359	0,497	85,205	10,298	2,691	14,174	35,427	68,352												
1,18E-04			0,025	0,002	0,004	0,002	0,018	0,002	1,18E-04	0,033	2,54E-04	8,16E-05	7,25E-05	2,018	3,068	5,105	6,743	14,672	121,77												
0,893	0,007	2,636	0,83	0,03	0,353	0,035	0,361	0,036	0,022	1,403	0,601	0,331	0,108	32,605	1,336	0,399	1,368	7	3,156												
1,982	0,027	5,844	2,535	7,076	2,372	0,109	1,177	0,112	0,085	4,993	2,865	1,267	0,413	60,783	3,995	1,311	2,223	37,798	13,541												
2,773	0,046	8,178	3,776	0,141	2,195	0,147	1,548	0,151	0,14	6,327	3,938	1,56	0,549	94,545	23,445	9,375	26,621	253,457	133,872												
0,001	0,002		0,318	0,017	0,12	0,024	0,189	0,024	0,006	0,389	0,166	0,021	0,012	4,189	17,705	13,801	19,24	61,623	296,023												
5,635	0,096	16,61	8,447	5,215	5,386	0,366	3,844	0,376	0,297	15,693	8,95	3,865	1,304	206,365																	
															730,106	369,977	182,252	507,649	498,13												
2,415	0,041	7,118	3,62	2,235	2,308	0,157	1,647	0,161	0,127	6,725	3,835	1,656	0,559	88,406																	
																												432,687	2,492	16,501	11,614
																												1317,113	12,093	40,085	45,488
																												13,789	1,256	3,522	3,339
																												185,373	7,257	9,654	20,568
																				65,334	50,64	3,466			109,447	1275,491	504,616				
																				5,194	10,807	0,56			12,328	70,717					
0,021	8,56E-04	0,062	0,066	0,05	0,044	0,003	0,046	0,004	0,003	0,252	0,078	0,075	0,022	0,908	1,995	2,416	3,12	5,219	7,049												
																				15,691	24,224	21,478			105,63	169,861					
19,2181178	0,469855804	58,151	43,293	29,781	27,858	1,955	23,252	2,68	1,71811784	95,851	55,61525382	27,49108158	9,100072519	966,413	1013,363	498,667	1631,336	2027,65	4875,761	1834,704	696,975	800,403	1013,362	498,667	1758,472	3543,72	4770,32	1948,962	23,098	69,762	81,009

LNFSF	LSECF	LNONM	LNFPM	LNFSM	LSECM	CAPAG	CAPNAG	LAND	ENTR	RURHHP	RURHHNP	URBHHP	URBHHNP	GOV	ROW	S-I	DIRTAX	IMPTAX	VATAX	INDTAX	FACTAX	TOTAL
										7,083	16,827	0,24	0,822									61,772
										3,704	12,048	0,222	0,788									50,174
										16,16	51,378	0,953	2,618									210,408
										13,239	42,698	0,754	2,92									137,744
										21,629	67,706	1,243	4,908									238,824
										1,24	3,888	0,074	0,292									12,496
										0,996	2,799	0,056	0,123									7,621
										2,204	5,766	0,088	0,254									17,734
										7,234	23,184	0,398	1,663									94,085
										5,282	14,335	0,239	0,53									39,264
										9,438	30,073	0,554	2,247									105,218
										11,062	36,179	0,648	2,847									119,157
										31,276	101,255	1,892	7,337									378,332
										11,038	27,108	0,395	1,46									88,474
										7,762	25,426	0,434	1,64									100,758
										15,797	49,432	0,891	3,57									181,477
										20,147	62,197	1,152	3,406									242,015
										12,811	40,392	0,723	2,432									174,941
										18,573	57,466	1,055	3,011									244,007
										19,713	57,066	1,022	3,64									233,841
										6,218	16,01	0,238	0,808									56,574
																						0,034
										0,006	0,101	5,01E-06	1,05E-04									5,251
										0,091	0,897	0,005	0,016									62,755
										0,002	0,066	7,56E-04	0,003									24,917
										0,168	1,317	0,011	0,037									116,492
																						9,717
																						1,654
																						19,218
										8,53E-04	0,016	7,69E-07	1,62E-05									0,471
																						58,152
										0,031	0,562	2,78E-05	5,84E-04									43,295
										0,003	0,15	0,002	0,011									29,781
										0,04	0,751	4,15E-04	0,002									27,86
																						1,957
																						23,251
																						2,681
										0,003	0,046	2,26E-06	4,74E-05									1,717
																						95,851
										0,083	1,474	3,76E-04	0,003									55,616
																						27,49
										0,003	0,052	2,58E-06	5,43E-05									9,101
										43,852	136,439	2,831	8,393									966,414
																						1013,362
																						498,667
										25,649	70,706	0,573	3,341									1631,336
																						2027,651
										75,236	346,862	21,97	165,992									4875,763
										97,326	467,013	47,818	293,919		41,437							1834,704
										3,7	20,16	1,479	9,617		317,31							696,975
										58,127	270,631	24,413	163,576		77,092							800,402
																227,685						1013,362
										8,092	51,889	5,665	82,624			49,906						498,667
										159,99	856,603	82,578	568,783		15,595							1758,471
										131,443	651,607	44,61	339,914		62,611	1041,299						3543,719
										34,887	228,631	15,101	236,87	516,066	791,956							4770,32
																						1948,962
																						23,098
																						69,762
																						81,008
																						531,673
																						155,894
																						83,026
																						266,431
																						678,785
																						421,232
																						724,209
																						2288,113
																						310,24
							2268,02							-1,413								2266,607
29,188	1,025	28,955	48,029	48,433	6,458	200,81		85,741	48,705					8,446								969,085
260,678	27,998	43,154	145,021	367,173	128,859	466,884		201,246	1052,261					39,564	188,055							4335,67
17,793	3,699	2,231	11,304	17,364	5,16	10,427		5,079	188,885					1,192								285,04
224,015	120,21	8,687	62,076	245,814	265,806	40,626		18,174	881,61					12,021	216,044							2317,934
																	189,633	99,605	24,337	336,883	17,912	668,371
						5,462	20,093															2034,549
										77,394	453,464	22,753	348,334	92,495	324,45							1318,89
									95,146	10,35	33	1,956	49,181									189,633
																						99,605
																						24,337
																						336,883
	2,961				14,95																	17,912
531,674	155,893	83,027	266,43	678,784	421,233	724,209	2288,113	310,24	2266,607	969,0829	4335,67	285,0376	2317,93281	668,371	2034,55	1318,89	189,633	99,605	24,337	336,883	17,912	

APPENDIX 3B: Social accounting matrix for subsistance and commercial production in Tanzania in 2001

	AFOODSUB	AFOODCOM	ACASHSUB	ACASHCOM	ALIFIHUSUB	ALIFIHUCOM	APROCESUB	APROCECOM	ATRADE	ATRANS	AMANUF	ASERVI	CFOOD	CCASH	CLIFIHU	CPROCE	CTRADE	CTRANS	CMANUF	CSERVI	FSUB	LCHILD
AFOODSUB													1046,432									
AFOODCOM													1748,484									
ACASHSUB														5,955								
ACASHCOM														611,304								
ALIFIHUSUB															191,515							
ALIFIHUCOM															774,899							
APROCESUB																100,269						
APROCECOM																1531,067						
ATRADE																	1013,362					
ATRANS																		498,667				
AMANUF																			2027,651			
ASERVI																				4875,763		
CFOOD		202,451				28,14		605,402			0,153	51,045										
CCASH				49,855				214,625			79,975	0,255										
CLIFIHU		1,946		8,115		14,62		120,364			25,721	35,797										
CPROCE						2,096		39,484			0,099	33,242										
CTRADE		207,224		99,988		55,539		115,663	12,858	10,404	163,927	120,074										
CTRANS		26,441		22,102		7,884		11,556	73,356	17,959	39,45	101,745										
CMANUF		49,493		52,593		19,946		49,874	17,367	38,047	654,719	390,194										
CSERVI		3,551		10,531		7,594		28,551	114,86	27,182	135,594	2618,947										
FSUB	1046,432	104,169	5,955	1,03	191,515	39,768	100,269	87,107				372,715										
LCHILD		8,34		3,27		9,792		0,159	0,129		1,147	0,26										
LNONF		45,087		5,689		12,047		0,6	0,938		2,216	3,183										
LNFPF		29,874		36,626		2,447		1,94	1,907		1,804	6,411										
LNFSF		286,585		28,942		85,205		14,174	10,298	2,691	35,427	68,352										
LSECF		2,426		0,091		2,018		6,743	3,068	5,105	14,672	121,77										
LNONM		27,722		9,44		32,605		1,368	1,336	0,399	7	3,156										
LNFPM		83,906		62,874		60,783		2,223	3,995	1,311	37,798	13,541										
LNFSM		101,574		35,895		94,545		26,621	23,445	9,375	253,457	133,872										
LSECM		7,049		1,601		4,189		19,24	17,705	13,801	61,623	296,023										
CAPAG		391,076		126,768		206,365																
CAPNAG								182,252	730,106	369,977	507,649	498,13										
LAND		167,51		54,324		88,406																
ENTR																						
RURHHP																					432,687	2,492
RURHHNP																					1317,113	12,093
URBHHP																					13,789	1,256
URBHHNP																					185,373	7,257
GOV																						
ROW													65,334	50,64	3,466	109,447			1275,491	504,616		
S-I																						
DIRTAX																						
IMPTAX													5,194	10,807	0,56	12,328			70,717			
VATAX		2,059		1,572		0,908		3,12	1,995	2,416	5,219	7,049										
INDTAX													15,691	24,224	21,478	105,63			169,861			
FACTAX																						
TOTAL	1046,432	1748,483	5,955	611,306	191,515	774,897	100,269	1531,066	1013,363	498,667	2027,65	4875,761	2881,135	702,93	991,918	1858,741	1013,362	498,667	3543,72	5380,379	1948,962	23,098

LNONF	LNFPF	LNFSF	LSECF	LNONM	LNFPM	LNFSM	LSECM	CAPAG	CAPNAG	LAND	ENTR	RURHHP	RURHHNP	URBHHP	URBHHNP	GOV	ROW	S-I	DIRTAX	IMPTAX	VATAX	INDTAX	FACTAX	TOTAL
																								1046,432
																								1748,484
																								5,955
																								611,304
																								191,515
																								774,899
																								100,269
																								1531,067
																								1013,362
																								498,667
																								2027,651
																								4875,763
												339,933	1210,247	61,091	341,237		41,437							2881,136
												4,131	25,59	1,498	9,691		317,31							702,93
												101,979	407,07	27,244	171,97		77,092							991,918
												185,64	927,309	83,151	572,124		15,595							1858,74
																		227,685						1013,362
												8,092	51,889	5,665	82,624			49,906						498,667
												131,443	651,607	44,61	339,914		62,611	1041,299						3543,719
												110,123	575,494	37,071	402,861	516,066	791,956							5380,38
																								1948,962
																								23,098
																								69,762
																								81,008
																								531,673
																								155,894
																								83,026
																								266,431
																								678,785
																								421,232
																								724,209
																								2288,113
																								310,24
									2268,02							-1,413								2266,607
16,501	11,614	29,188	1,025	28,955	48,029	48,433	6,458	200,81		85,741	48,705					8,446								969,085
40,085	45,488	260,678	27,998	43,154	145,021	367,173	128,859	466,884		201,246	1052,261					39,564	188,055							4335,67
3,522	3,339	17,793	3,699	2,231	11,304	17,364	5,16	10,427		5,079	188,885					1,192								285,04
9,654	20,568	224,015	120,21	8,687	62,076	245,814	265,806	40,626		18,174	881,61					12,021	216,044							2317,934
																			189,633	99,605	24,337	336,883	17,912	668,371
								5,462	20,093															2034,549
												77,394	453,464	22,753	348,334	92,495	324,45							1318,89
											95,146	10,35	33	1,956	49,181									189,633
																								99,605
																								24,337
																								336,883
			2,961				14,95																	17,912
69,762	81,009	531,674	155,893	83,027	266,43	678,784	421,233	724,209	2288,113	310,24	2266,607	969,085	4335,67	285,039	2317,936	668,371	2034,55	1318,89	189,633	99,605	24,337	336,883	17,912	

Appendix 4: Sets, Parameters and Variables used in the Model

Sets

$a \in A$	Activities
$a \in AAGR(\subset A)$	Agricultural activities
$a \in ANAGR(\subset A)$	Non-agricultural activities
$c \in C$	Commodities
$c \in CAGR(\subset C)$	Agricultural commodities
$c \in CNAGR(\subset C)$	Non-agricultural commodities
$c \in CD(\subset C)$	Commodities with domestic sales and domestic output
$c \in CDN(\subset C)$	Commodities not in CD
$c \in CE(\subset C)$	Exported commodities
$c \in CEN(\subset C)$	Commodities not in CE
$c \in CM(\subset C)$	Imported commodities
$c \in CMN(\subset C)$	Commodities not in CM
$c \in CX(\subset C)$	Commodities with domestic production
$f \in F$	Factors
$i \in INS$	Institutions
$i \in INSD(\subset INS)$	Domestic institutions
$i \in INSDNG(\subset INSD)$	Domestic non-government institutions
$h \in H(\subset INSDNG)$	Households

Parameters

ava_a *	Constant in translog price index
$afva_{fa}$ *	Intercept in translog factor expenditure share
$cwts_c$	Weight of commodity *c* in consumer price index (CPI)
$dwts_c$	Weight of commodity *c* in the producer price index
ica_{ca}	Quantity of *c* as intermediate input per unit of activity *a*
$\text{int}\, a_a$	Quantity of aggregate intermediate input per activity unit
iva_a	Quantity of value-added per activity unit
$\overline{mps_i}$	Marginal propensity to save for domestic institution *i*
pwe_c	Export price (in foreign currency)
pwm_c	Import price (in foreign currency)
$qdst_c$	Quantity of stock change
$\overline{qg}_c$	Exogenous government demand
$\overline{qinv}_c$	Exogenous investment demand
$shif_{if}$	Share of domestic institution *i* in income of factor *f*
$shii_{ii'}$	Share of net income of institution *i* in post-tax post-savings income of institution *i'*
ta_a	Tax rate for activity *a* on producer gross output value

te_c	Rate of tax on exports for commodity *c*
tf_f	Rate of direct tax on factor *f*
$\overline{tins_i}$	Rate of exogenous direct tax on domestic institution *i*
tm_c	Rate of import tariff for commodity *c*
tq_c	Rate of sales tax for commodity *c*
$trnsfr_{if}$	Transfer from factor *f* to institution *i*
tva_a	Rate of value-added tax for activity *a*
α_c^{ac}	Shift parameter for domestic commodity aggregation function
α_c^q	Shift parameter for Armington function
α_c^t	Shift parameter for CET function
β^a *	Capital sectoral mobility factor
β_{fa}^{va} *	Expenditure share elasticities in translog
β_{ch}^m	Marginal share of consumption spending on marketed commodity *c* for household *h*
δ_{ac}^{ac}	Share parameter for domestic commodity aggregation function
δ_c^q	Share parameter for Armington function
δ_c^t	Share parameter for CET function
γ_{ffa}^{va} *	Cross price substitution elasticities in translog
γ_{ch}^m	Per capital subsistence consumption of marketed commodity *c* for household *h*
ρ_c^{ac}	Domestic commodity aggregation function exponent
ρ_c^q	Armington function exponent
ρ_c^t	CET function exponent
θ_{ac}	Yield of commodity *c* per unit of activity *a*
ν_f *	Capital depreciation rate for factor *f*
η_{fat}^a *	Sector share of new capital factor *f* to sector *a* at time *t*

Exogenous variables

$\overline{CPI}$	Consumer price index
$\overline{DTINS}$	Change in domestic institution tax share
$\overline{FSAV}$	Foreign savings
$\overline{GADJ}$	Government demand scaling factor
$\overline{IADJ}$	Investment scaling factor (for fixed capital formation)
$\overline{MPSADJ}$	Savings rate scaling factor
$\overline{QFS_f}$	Quantity of factor *f* supplied
$\overline{TINSADJ}$	Direct tax scaling factor
$\overline{WFDIST_{fa}}$	Wage distortion variable for factor *f* in activity *a*

Endogenous variables

AWF_{ft}^{a} *	Average capital rental rate in time period *t*
DMPS	Change in marginal propensity to save for selected institutions
DPI	Producer price index for domestically marketed output
EG	Total current government expenditure
EH_h	Household consumption expenditure
EXR	Exchange rate
GOVSHR	Government consumption share of nominal absorption
GSAV	Government savings
INVSHR	Investment share of nominal absorption
MPS_i	Marginal propensity to save for domestic non-government institution
PA_a	Output price of activity a
PDD_c	Demand price for commodity *c* produced and sold domestically
PDS_c	Supply price for commodity *c* produced and sold domestically
PE_c	Price of exports (in domestic currency)
$PINTA_a$	Price of intermediate aggregate for activity *a*
PK_{ft} *	Unit price of capital in time period *t*
PM_c	Price of imports (in domestic currency)
PQ_c	Price of composite good *c*
PVA_a	Value added price for activity *a*
PWE_c	World price of exports
PWM_c	World price of imports
PX_c	Average output price for commodity *c*
QA_a	Level of domestic activity
QD_c	Quantity sold domestically of domestic output
QE_c	Quantity of exports
QF_{fa}	Quantity demanded of factor *f* from activity *a*
QG_c	Quantity of government consumption
QH_{ch}	Quantity consumed of marketed commodity *c* by household *h*
$QINT_{ca}$	Quantity of intermediate demand for *c* from activity *a*
$QINTA_a$	Quantity of aggregate intermediate input for activity *a*
$QINV_c$	Quantity of fixed investment demand for commodity *c*
QM_c	Quantity of imports
QQ_c	Quantity of composite goods supplied to the domestic market
QVA_a	Quantity of aggregate value added
QX_c	Quantity of aggregate marketed domestic output of commodity *c*
$QXAC_{ac}$	Quantity of marketed output of commodity *c* from activity *a*
RWF_f *	Real average factor price for factor *f*
$SFVA_{fa}$ *	Factor expenditure shares in translog
TABS	Total nominal absorption

$TINS_i$	Rate of direct tax on domestic institution *i*
$TRII_{ii'}$	Transfers to domestic institution to domestic institution
WF_f	Economy-wide wage (rent) for factor *f*
YF_f	Factor income
YG	Government revenue
YI_i	Income of (domestic non-governmental) institution *i*
YIF_f	Income of domestic institution *i* from factor *f*
ΔK^a_{fat} *	Quantity of new capital by activity *a* for time period *t*

* Denotes deviation from the standard model

Appendix 5: Model Equations

Prices

Import price:

$$PM_c = \overline{PWM_c} \cdot (1 + tm_c) \cdot EXR \qquad c \in CM \qquad (1)$$

Export price:

$$PE_c = \overline{PWE_c} \cdot (1 - te_c) \cdot EXR \qquad c \in CE \qquad (2)$$

Consumer price equals producer price:

$$PDD_c = PDS_c \qquad c \in CD \qquad (3)$$

Absorption:

$$PQ_c \cdot (1 - tq_c) \cdot QQ_c = PDD_c \cdot QD_c + PM_c \cdot QM_c \qquad c \in (CD \cup CM) \qquad (4)$$

Marketed output value:

$$PX_c \cdot QX_c = PDS_c \cdot QD_c + PE_c \cdot QE_c \qquad c \in CX \qquad (5)$$

Aggregate intermediate input price:

$$PINTA_a = \sum_{c \in C} PQ_c \cdot ica_{ca} \qquad a \in A \qquad (6)$$

Activity revenue and costs:

$$PA_a \cdot QA_a = PVA_a \cdot QVA_a + PINTA_a \cdot QINTA_a \qquad a \in A \qquad (7)$$

Consumer price Index:

$$\overline{CPI} = \sum_{c \in C} PQ_c \cdot cwts_c \qquad (8)$$

Producer price index:

$$DPI = \sum_{c \in C} PDS_c \cdot dwts_c \qquad (9)$$

Production and Trade

Demand for aggregate value added (Leontief):

$$QVA_a = iva_a \cdot QA_a \qquad a \in A \qquad (10)$$

Demand for aggregate intermediate (Leontief):

$$QINTA_a = in\ ta_a \cdot QA_a \qquad a \in A \qquad (11)$$

Aggregate price index (translog) that implicitly determines real output:

$$Log(PVA_a) = ava_a + \sum_{f \in F} \left(afva_{fa} \cdot Log(WF_f \cdot WFDIST_{fa}) \right) +$$

$$+ \frac{1}{2} \cdot \sum_{f \in F} \sum_{f' \in F} \left(\gamma^{va}_{ff'a} \cdot Log(WF_f \cdot WFDIST_{fa}) \cdot Log(WF_{f'} \cdot WFDIST_{f'a}) \right) \qquad a \in A,\ f \in F \qquad (12)$$

Factor expenditure shares (translog):

$$SFVA_{fa} = afva_{fa} + \beta^{va}_{fa} \cdot Log(QVA_a) +$$

$$\sum_{f' \in F} \left(\gamma^{va}_{ff'a} \cdot Log(WF_{f'} \cdot WFDIST_{f'a}) \right) \qquad a \in A,\ f \in F \qquad (13)$$

Factor demand:

$$WF_f \cdot WFDIST_{fa} \cdot QF_{fa} = SFVA_{fa} \cdot PVA_a \cdot (1 - tva_a) \cdot QVA_a \qquad a \in A,\ f \in F \qquad (14)$$

Disaggregated intermediate input demand:

$$QINT_{ca} = ica_{ca} \cdot QINTA_a \qquad a \in A, c \in C \qquad (15)$$

Commodity production and allocation:

$$QXAC_{ac} = \theta_{ac} \cdot QA_a \qquad a \in A, c \in CX \qquad (16)$$

Output aggregation function:

$$QX_c = \alpha_c^{ac} \cdot \left(\sum_{a \in A} \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}} \right)^{-\frac{1}{\rho_c^{ac}-1}} \qquad c \in CX \qquad (17)$$

First order condition for output aggregation function:

$$PXAC_{ac} = PX_c \cdot QX_c \cdot \left(\sum_{a \in A} \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}} \right)^{-1} \cdot \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}-1} \qquad a \in A, c \in CX \qquad (18)$$

Output transformation (CET) function:

$$QX_c = \alpha_c^t \cdot \left(\delta_c^t \cdot QE_c^{\rho_c^t} + \left(1-\delta_c^t\right) \cdot QD_c^{\rho_c^t} \right)^{\frac{1}{\rho_c^t}} \qquad c \in \left(CE \cap CD\right) \qquad (19)$$

Export-domestic supply ratio:

$$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PDS_c} \cdot \frac{1-\delta_c^t}{\delta_c^t} \right)^{\frac{1}{\rho_c^t-1}} \qquad c \in \left(CE \cap CD\right) \qquad (20)$$

Output transformation for non-exported commodities:

$$QX_c = QD_c + QE_c \qquad c \in \left(CD \cap CEN\right) \cup \left(CE \cap CDN\right) \qquad (21)$$

Composite supply (Armington) function:

$$QQ_c = \alpha_c^q \cdot \left(\delta_c^q \cdot QM_c^{-\rho_c^q} + \left(1-\delta_c^q\right) \cdot QD_c^{-\rho_c^q} \right)^{-\frac{1}{\rho_c^q}} \qquad c \in \left(CM \cap CD\right) \qquad (22)$$

Import-domestic demand ratio:

$$\frac{QM_c}{QD_c} = \left(\frac{PDD_c}{PM_c} \cdot \frac{\delta_c^q}{1-\delta_c^q} \right)^{\frac{1}{1+\rho_c^q}} \qquad c \in \left(CM \cap CD\right) \qquad (23)$$

Composite supply for non-imported outputs and non-produced imports:

$$QQ_c = QD_c + QM_c \qquad c \in \left(CD \cap CMN\right) \cup \left(CM \cap CDN\right) \qquad (24)$$

Institutions

Factor income:

$$YF_f = \sum_{a \in A} \left(WF_f \cdot WFDIST_{fa} \cdot QF_{fa} \right) \qquad f \in F \qquad (25)$$

Institutional factor incomes:

$$YIF_f = shif_{if} \cdot \left[\left(1-tf_f\right) \cdot YF_f - trnsfr_{rowf} \cdot EXR \right] \qquad i \in INSD,\ f \in F \qquad (26)$$

Income of domestic non-government institutions:

$$YI_i = \sum_{f \in F} YIF_{if} + \sum_{i' \in INSDNG'} TRII_{ii'} + trnsfr_{igov} \cdot \overline{CPI} + trnsfr_{irow} \cdot EXR \qquad i \in INSDNG \qquad (27)$$

Intra-institutional transfers:

$$TRII_{ii'} = shii_{ii'} \cdot (1 - MPS_{i'}) \cdot (1 - TINS_{i'}) \cdot YI_{i'} \qquad i \in INSDNG, i' \in INSDNG' \quad (28)$$

Household consumption expenditure:

$$EH_h = \left(1 - \sum_{i \in INSDNG} shii_{ih}\right) \cdot (1 - MPS_h) \cdot (1 - TINS_h) \cdot YI_h \qquad h \in H \quad (29)$$

Household consumption demand:

$$PQ_c \cdot QH_{ch} = PQ_c \cdot \gamma_{ch}^m + \beta_{ch}^m \cdot \left(EH_h - \sum_{c' \in C} \left(PQ_{c'} \cdot \gamma_{c'h}^m\right)\right) \qquad c \in C, h \in H \quad (30)$$

Investment demand:

$$QINV_c = IADJ \cdot \overline{qinv_c} \quad (31)$$

Government consumption demand:

$$QG_c = GADJ \cdot \overline{qg_c} \quad (32)$$

Government revenue:

$$YG = \sum_{i \in INSDNG} TINS_i \cdot YI_i + \sum_{f \in F} tf_f \cdot YF_f + \sum_{a \in A} tva_a \cdot PVA_a \cdot QVA_a$$
$$+ \sum_{a \in A} ta_a \cdot PA_a \cdot QA_a + \sum_{c \in CM} tm_c \cdot pwm_c \cdot QM_c \cdot EXR + \sum_{c \in CE} te_c \cdot pwe_c \cdot QE_c \cdot EXR$$
$$+ \sum_{c \in C} tq_c \cdot PQ_c \cdot QQ_c + \sum_{f \in F} YIF_{govf} + trnsfr_{govrow} \cdot EXR \quad (33)$$

Government expenditures:

$$EG = \sum_{c \in C} PQ_c \cdot QG_c + \sum_{i \in INSDNG} trnsfr_{igov} \cdot \overline{CPI} \quad (34)$$

System constraints

Factor market:

$$\sum_{a \in A} QF_{fa} = QFS_f \qquad f \in F \quad (34)$$

Composite commodity market:

$$QQ_c = \sum_{a \in A} QINT_{ca} + \sum_{h \in H} QH_{ch} + QG_c + QINV_c + qdst_c + QT_c \qquad c \in C \quad (36)$$

Current account balance for the rest of the world:

$$\sum_{c \in CM} pwm_c \cdot QM_c + \sum_{f \in F} trnsfr_{rowf} = \sum_{c \in CE} pwe_c \cdot QE_c + \sum_{i \in INSD} trnsfr_{irow} + \overline{FSAV} \quad (37)$$

Government balance:

$$YG = EG + GSAV \quad (38)$$

Direct institutional tax rates:

$$TINS_i = \overline{tins_i} \cdot \left(1 + \overline{TINSADJ} \cdot tins01_i\right) + \overline{DTINS} \cdot t \qquad i \in INSDNG \quad (39)$$

Institutional savings rates:

$$MPS_i = \overline{mps_i} \cdot \left(1 + \overline{MPSADJ} \cdot mps01_i\right) + DMPS \cdot mps01_i \qquad i \in INSDNG \quad (40)$$

Savings-investment balance:

$$\sum_{i \in INSDNG} MPS_i \cdot (1 - TINS_i) \cdot YI_i + GSAV + EXR \cdot \overline{FSAV} = \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c \quad (41)$$

Total absorption:

$$TABS = \sum_{h \in H} \sum_{c \in C} PQ_c \cdot QH_{ch} + \sum_{c \in C} PQ_c \cdot QG_c + \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c \quad (42)$$

Ratio of investment to absorption:

$$INVSHR \cdot TABS = \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c \quad (43)$$

Ratio of government consumption to absorption:

$$GOVSHR \cdot TABS = \sum_{c \in C} PQ_c \cdot QG_c \quad (44)$$

Introducing Dynamics

Average economy-wide rental rate for capital:

$$AWF_{ft}^{a} = \sum_{a \in A} \left[\left(\frac{QF_{fat}}{\sum_{a' \in A} QF_{fa't}} \right) \cdot WF_{ft} \cdot WFDIST_{fat} \right] \qquad f \text{ is capital, } a \in A, a' \in A, t \in T \quad (45)$$

Each sector's share of new capital investment:

$$\eta_{fat}^{a} = \left(\frac{QF_{fat}}{\sum_{a' \in A} QF_{fa't}} \right) \cdot \left(\beta^{a} \cdot \left(\frac{WF_{ft} \cdot WFDIST_{fat}}{AWF_{ft}^{a}} - 1 \right) + 1 \right) \qquad f \text{ is capital, } a \in A, a' \in A, t \in T \quad (46)$$

Final quantity allocated to each sector:

$$\Delta K_{fat}^{a} = \eta_{fat}^{a} \cdot \left(\frac{\sum_{c \in C} PQ_{ct} \cdot QINV_{ct}}{PK_{ft}} \right) \qquad f \text{ is capital}, a \in A, c \in C, t \in T \quad (47)$$

Unit capital price:

$$PK_{ft} = \sum_{c \in C} PQ_{ct} \cdot \frac{QINV_{ct}}{\sum_{c' \in C} QINV_{c't}} \qquad f \text{ is capital}, a \in A, c \in C, c' \in C, t \in T \quad (48)$$

New aggregate quantity of capital:

$$QFS_{ft+1} = QFS_{ft} \cdot \left(1 + \frac{\sum_{a \in A} \Delta K_{fat}}{QFS_{ft}} - \nu_f \right) \qquad f \text{ is capital}, a \in A, t \in T \quad (49)$$

New sectoral quantity of capital:

$$QF_{fat+1} = QF_{fat} \cdot \left(1 + \frac{\Delta K_{fat}^{a}}{QF_{fat}} - \nu_f \right) \qquad f \text{ is capital}, a \in A, t \in T \quad (50)$$

Appendix 6: Imposed elasticities used in the model

Trade elasticities[1]:

δ_c^q Elasticity of substitution between imports and domestic output in domestic demand:

Food crops	3.0
Cash crops	3.0
Livestock, hunting	3.0
Processed food	1.5
Manufactures	1.5
Services	1.5

δ_c^t Elasticity of transformation for domestic marketed output between exports and domestic supplies:

Food crops	1.2
Cash crops	5.0
Livestock, hunting	1.2
Processed food	1.2
Manufactures	1.2
Services	0.5

Production elasticities:

Elasticity of substitution between primary factors in the translog production function:

Between unskilled female labour categories 'USFLAB' (LNONF and LNFPF)	3.0
Between unskilled male labour categories 'USMLAB' (LNONM and LNFPM)	3.0
Between skilled female labour categories 'SFLAB' (LNFSF and LSECF)	0.8
Between skilled male labour categories 'SMLAB' (LNFSM and LSECM)	0.8
Between unskilled labour categories 'USLAB' ('USFLAB', 'USMLAB' and LCHILD)	
Agricultural sector	0.5
Non-agricultural sector	2.0
Between unskilled labour and subsistence 'LABSUB' ('USLAB' and FSUB)	3.0
Between skilled labour 'SKLAB' ('SFLAB' and 'SMLAB')	2.5
Between total labour 'TOTLAB' ('LABSUB' and 'SKLAB')	0.9
Between labour, land, and capital 'TOTFAC' ('TOTLAB', LAND, CAPAG, CAPNAG)	0.8

Expenditure elasticities[2]:

	Rural households	Urban households
Food crops	0.93	0.72
Cash crops	0.99	1.25
Livestock, hunting	0.99	1.25
Transport	1.98	1.98
Processed food	1.51	1.46
Manufactures	1.51	1.46
Services	1.51	1.46

[1] Trade elasticities were adopted from Wobst (2001).
[2] Expenditure elasticities were adopted from Delgado and Minot (2000).

Appendix 7: Sensitivity Analysis

The basic model is a stylised description of the economy where data from various different sources have been merged into one consistent model. The accuracy of the results depends on the quality of the data and assumptions used in the model, and thus it is important to test how sensitive the model is to possible misevaluations in the estimates used. Even though the latest data and available econometric estimates were used in constructing the basic model, there is still scope for evaluating the robustness of the model in different circumstances. The most common source of discrepancy between the estimates is the elasticities used in the model that determine how the economy adjusts to the changes in prices and quantities. In this section the sensitivity of the model to the assumptions made are tested by varying the used values through a wide range of alternative specifications and comparing the original results to the new estimates.

The model proves to be most sensitive to the substitution elasticities between the different primary factors of production. Table A1 shows the estimated annual growth rates with the original substitution elasticities as well as new values for elasticity gained by taking 75 up to 175 percent shares of the original values, in 25 percent intervals. The overall annual production growth falls by 0.1 percentage points by every 25 percent that the substitution elasticities are increased. The most sensitive sector for the specification of the substitution elasticities is the cash crop sector. It is important to note, however, that the elasticities change in a similar way in all regions and thus implications of regional shifts in production are withheld. Furthermore, even when the elasticities are almost doubled indicating a significant change in the production technology, the overall growth rate only falls by eight percent. This change is not large enough to change any of the qualitative results gained in this paper, nor is it likely to cause major discrepancies between the quantitative results shown for different scenarios, assuming that other assumptions used in the model are unchanged.

% change	75	100	125	150	175
Agricultural sector					
Food crops in Dodoma	+0.10	3.68	+0.02	-0.18	-0.26
Food crops in Arusha	+0.11	3.69	+0.04	-0.19	-0.27
Food crops in Kilimanjaro	+0.11	3.63	+0.05	-0.19	-0.27
Food crops in Tanga	+0.10	3.66	+0.02	-0.18	-0.26
Food crops in Morogoro	+0.10	3.65	+0.03	-0.18	-0.26
Food crops in Pwani	+0.10	3.65	+0.02	-0.18	-0.26
Food crops in Dar	+0.10	3.65	+0.00	-0.17	-0.25
Food crops in Lindi	+0.10	3.72	+0.00	-0.17	-0.25
Food crops in Manyara	+0.11	3.70	+0.04	-0.19	-0.27
Food crops in Mtwara	+0.10	3.72	-0.01	-0.17	-0.25
Food crops in Ruvuma	+0.11	3.72	+0.02	-0.18	-0.26
Food crops in Iringa	+0.10	3.67	+0.02	-0.18	-0.26
Food crops in Mbeya	+0.11	3.68	+0.03	-0.18	-0.26
Food crops in Sinyanga	+0.10	3.72	+0.00	-0.18	-0.26
Food crops in Tabora	+0.11	3.72	+0.03	-0.19	-0.27
Food crops in Rukwa	+0.11	3.78	+0.01	-0.19	-0.27
Food crops in Kigoma	+0.11	3.74	+0.03	-0.19	-0.27
Food crops in Shinyanga	+0.11	3.71	+0.04	-0.19	-0.28
Food crops in Kagera	+0.11	3.78	+0.04	-0.19	-0.28
Food crops in Mwanza	+0.11	3.78	+0.02	-0.19	-0.27
Food crops in Mara	+0.11	3.79	+0.00	-0.18	-0.27
Cash crops in Dodoma	+0.47	4.92	-0.11	-0.66	-0.93
Cash crops in Arusha	+0.46	4.95	-0.12	-0.66	-0.92
Cash crops in Kilimanjaro	+0.49	4.91	-0.12	-0.68	-0.95
Cash crops in Tanga	+0.44	5.02	-0.10	-0.64	-0.89
Cash crops in Morogoro	+0.49	4.83	-0.12	-0.69	-0.96
Cash crops in Pwani	+0.48	4.68	-0.12	-0.67	-0.94
Cash crops in Dar	+0.48	4.64	-0.12	-0.68	-0.95
Cash crops in Lindi	+0.48	4.78	-0.12	-0.68	-0.95
Cash crops in Manyara	+0.46	4.88	-0.12	-0.65	-0.91
Cash crops in Mtwara	+0.48	4.82	-0.12	-0.68	-0.95
Cash crops in Ruvuma	+0.47	5.02	-0.12	-0.67	-0.93
Cash crops in Iringa	+0.46	5.05	-0.11	-0.65	-0.91
Cash crops in Mbeya	+0.46	4.95	-0.13	-0.65	-0.91
Cash crops in Sinyanga	+0.47	5.06	-0.11	-0.67	-0.93
Cash crops in Tabora	+0.48	5.20	-0.12	-0.67	-0.94
Cash crops in Rukwa	+0.48	5.37	-0.12	-0.68	-0.95
Cash crops in Kigoma	+0.47	5.09	-0.13	-0.66	-0.92
Cash crops in Shinyanga	+0.48	5.20	-0.12	-0.67	-0.94
Cash crops in Kagera	+0.48	5.17	-0.13	-0.67	-0.93
Cash crops in Mwanza	+0.49	5.35	-0.12	-0.68	-0.95
Cash crops in Mara	+0.48	5.32	-0.12	-0.68	-0.95
Livestock/fishing/hunting	+0.13	3.76	+0.07	-0.21	-0.31
Non-agriculture					
Trade	+0.16	4.08	-0.83	-0.26	-0.38
Transport	+0.17	4.30	-0.85	-0.29	-0.42
Processed food	+0.16	4.07	-0.32	-0.27	-0.39
Manufacturing	+0.13	4.16	-0.12	-0.24	-0.35
Services	+0.02	3.94	+0.11	-0.13	-0.21
TOTAL	+0.13	3.97	-0.13	-0.23	-0.33

Table A1: Average annual growth of real GDP with different substitution elasticities between the primary factors of production in the base and change in growth rates relative to the base. Source: Author.

Other possible source of sensitivity in the model is the CES import aggregation and CET export transformation functions that describe the substitution possibilities for the traded commodities in the model. These elasticities, i.e. the parameter for Armington function δ_c^q and the parameter for CET function δ_c^t, determine the intensity of the substitution mechanism on one hand between domestic supply and imports, and on the other, domestic production and exports. The elasticities used in the current study were adopted from another recent CGE study on Tanzania by Wobst (2001). The following tables aid to assess how sensitive the model is to the assumptions made of these elasticities. Here the base model is run up to the year 2015 using the original values as well as 75 up to 175 percentage shares of the original values at 25 percentage points intervals. The most sensitive variables to these elasticities are likely to be the exchange rate (table A2), exports and imports (table A3), as well as total production (table A4 and A5).

% change in the elasticity	75	100	125	150	175
Real exchange rate (δ_c^q)	(.)	0.2	(.)	(.)	(.)
Real exchange rate (δ_c^t)	(.)	0.2	(.)	(.)	-0.1

Table A2: Annual change in the real exchange rates and the impact of changes in CES and CET elasticities. Source: Author.

The model proves to be very robust to the variation in the elasticities. The real exchange rate changes are small even in the base model, and the annual percentage change remains practically unchanged even when the elasticities range widely. The variation is also modest in terms of import and export growth rates. When the elasticity of substituting imported goods by domestic production increases, the growth of foreign trade slows down as more of the domestic production is used instead. On the other hand, the more lucrative it is to sell to the world market, the more the exports grow and as more foreign exchange is earned, so do the imports. The direction of the change is in line with the theoretical hypothesis, but the size of the change is modest.

% change in the elasticity	75	100	125	150	175
Exports (δ_c^q)	(.)	4.3	(.)	-0.1	-0.1
Imports (δ_c^q)	(.)	3.8	-0.1	-0.1	-0.1
Exports (δ_c^t)	(.)	4.3	(.)	+0.1	+0.1
Imports (δ_c^t)	-0.1	3.8	(.)	(.)	(.)

Table A3: Annual change in the imports and exports and the impact of changes in CES and CET elasticities. Source: Author.

% change	75	100	125	150	175
Agricultural sector					
Food crops in Dodoma	0.00	3.68	0.00	0.00	0.00
Food crops in Arusha	0.00	3.69	0.00	0.00	0.00
Food crops in Kilimanjaro	0.00	3.63	0.00	0.00	0.00
Food crops in Tanga	0.00	3.66	0.00	0.00	0.00
Food crops in Morogoro	0.00	3.65	0.00	0.00	0.00
Food crops in Pwani	0.00	3.65	0.00	0.00	0.00
Food crops in Dar	0.00	3.65	0.00	0.00	0.00
Food crops in Lindi	0.00	3.72	0.00	0.00	0.00
Food crops in Manyara	0.00	3.70	0.00	0.00	0.00
Food crops in Mtwara	0.00	3.72	0.00	0.00	0.00
Food crops in Ruvuma	0.00	3.72	0.00	0.00	0.00
Food crops in Iringa	0.00	3.67	0.00	0.00	0.00
Food crops in Mbeya	0.00	3.68	0.00	0.00	0.00
Food crops in Sinyanga	0.00	3.72	0.00	0.00	0.00
Food crops in Tabora	0.00	3.72	0.00	0.00	0.00
Food crops in Rukwa	0.00	3.78	0.00	0.00	0.00
Food crops in Kigoma	0.00	3.74	0.00	0.00	0.00
Food crops in Shinyanga	0.00	3.71	0.00	0.00	0.00
Food crops in Kagera	0.00	3.78	0.00	0.00	0.00
Food crops in Mwanza	0.00	3.78	0.00	0.00	0.00
Food crops in Mara	0.00	3.79	0.00	0.00	0.00
Cash crops in Dodoma	0.05	4.92	-0.04	-0.08	-0.11
Cash crops in Arusha	0.05	4.95	-0.04	-0.08	-0.11
Cash crops in Kilimanjaro	0.05	4.91	-0.04	-0.08	-0.11
Cash crops in Tanga	0.05	5.02	-0.04	-0.08	-0.11
Cash crops in Morogoro	0.05	4.83	-0.04	-0.08	-0.11
Cash crops in Pwani	0.05	4.68	-0.04	-0.08	-0.11
Cash crops in Dar	0.05	4.64	-0.04	-0.08	-0.11
Cash crops in Lindi	0.05	4.78	-0.04	-0.08	-0.11
Cash crops in Manyara	0.05	4.88	-0.04	-0.08	-0.10
Cash crops in Mtwara	0.05	4.82	-0.04	-0.08	-0.11
Cash crops in Ruvuma	0.05	5.02	-0.04	-0.08	-0.11
Cash crops in Iringa	0.05	5.05	-0.04	-0.08	-0.11
Cash crops in Mbeya	0.05	4.95	-0.04	-0.08	-0.11
Cash crops in Sinyanga	0.05	5.06	-0.04	-0.08	-0.11
Cash crops in Tabora	0.05	5.20	-0.04	-0.08	-0.11
Cash crops in Rukwa	0.05	5.37	-0.04	-0.08	-0.11
Cash crops in Kigoma	0.05	5.09	-0.04	-0.08	-0.11
Cash crops in Shinyanga	0.05	5.20	-0.04	-0.08	-0.11
Cash crops in Kagera	0.05	5.17	-0.04	-0.08	-0.11
Cash crops in Mwanza	0.05	5.35	-0.04	-0.08	-0.11
Cash crops in Mara	0.05	5.32	-0.04	-0.08	-0.11
Livestock/fishing/hunting	0.00	3.76	0.00	0.00	0.00
Non-agriculture					
Trade	0.00	4.08	0.00	0.00	0.00
Transport	0.00	4.30	0.00	0.00	0.00
Processed food	0.00	4.07	0.00	0.01	0.01
Manufacturing	-0.03	4.16	0.03	0.05	0.07
Services	0.00	3.94	-0.01	-0.01	-0.02
TOTAL	0.00	3.97	0.00	0.00	0.00

Table A4: Annual change in the growth of sectoral GDP in the base and the impact of changes in CES elasticities compared to the base. Source: Author.

% change	75	100	125	150	175
Agricultural sector					
Food crops in Dodoma	0.00	3.68	0.00	0.00	0.01
Food crops in Arusha	0.00	3.69	0.00	0.00	0.01
Food crops in Kilimanjaro	0.00	3.63	0.00	0.00	0.01
Food crops in Tanga	0.00	3.66	0.00	0.01	0.01
Food crops in Morogoro	0.00	3.65	0.00	0.00	0.01
Food crops in Pwani	0.00	3.65	0.00	0.01	0.01
Food crops in Dar	0.00	3.65	0.00	0.00	0.01
Food crops in Lindi	0.00	3.72	0.00	0.01	0.01
Food crops in Manyara	0.00	3.70	0.00	0.00	0.01
Food crops in Mtwara	0.00	3.72	0.00	0.01	0.01
Food crops in Ruvuma	0.00	3.72	0.00	0.00	0.01
Food crops in Iringa	0.00	3.67	0.00	0.00	0.01
Food crops in Mbeya	0.00	3.68	0.00	0.00	0.01
Food crops in Sinyanga	0.00	3.72	0.00	0.00	0.01
Food crops in Tabora	0.00	3.72	0.00	0.00	0.01
Food crops in Rukwa	0.00	3.78	0.00	0.01	0.01
Food crops in Kigoma	0.00	3.74	0.00	0.00	0.01
Food crops in Shinyanga	0.00	3.71	0.00	0.00	0.01
Food crops in Kagera	0.00	3.78	0.00	0.00	0.01
Food crops in Mwanza	0.00	3.78	0.00	0.00	0.01
Food crops in Mara	0.00	3.79	0.00	0.00	0.01
Cash crops in Dodoma	-0.09	4.92	0.07	0.12	0.17
Cash crops in Arusha	-0.09	4.95	0.07	0.12	0.17
Cash crops in Kilimanjaro	-0.08	4.91	0.07	0.12	0.16
Cash crops in Tanga	-0.09	5.02	0.07	0.12	0.17
Cash crops in Morogoro	-0.08	4.83	0.07	0.12	0.16
Cash crops in Pwani	-0.09	4.68	0.07	0.13	0.17
Cash crops in Dar	-0.09	4.64	0.07	0.13	0.17
Cash crops in Lindi	-0.09	4.78	0.07	0.13	0.17
Cash crops in Manyara	-0.09	4.88	0.07	0.12	0.17
Cash crops in Mtwara	-0.09	4.82	0.07	0.13	0.17
Cash crops in Ruvuma	-0.09	5.02	0.07	0.12	0.17
Cash crops in Iringa	-0.09	5.05	0.07	0.13	0.17
Cash crops in Mbeya	-0.09	4.95	0.07	0.12	0.17
Cash crops in Sinyanga	-0.09	5.06	0.07	0.12	0.17
Cash crops in Tabora	-0.09	5.20	0.07	0.13	0.17
Cash crops in Rukwa	-0.09	5.37	0.07	0.12	0.17
Cash crops in Kigoma	-0.09	5.09	0.07	0.12	0.17
Cash crops in Shinyanga	-0.09	5.20	0.07	0.13	0.18
Cash crops in Kagera	-0.09	5.17	0.07	0.12	0.17
Cash crops in Mwanza	-0.09	5.35	0.07	0.13	0.18
Cash crops in Mara	-0.09	5.32	0.07	0.13	0.17
Livestock/fishing/hunting	0.00	3.76	0.00	0.00	0.00
Non-agriculture					
Trade	-0.01	4.08	0.01	0.02	0.02
Transport	-0.01	4.30	0.01	0.01	0.02
Processed food	0.00	4.07	0.00	0.01	0.01
Manufacturing	0.00	4.16	0.00	0.00	0.00
Services	0.00	3.94	-0.01	-0.01	-0.01
TOTAL	-0.01	3.97	0.01	0.01	0.01

Table A5: Annual change in the growth of sectoral GDP in the base and the impact of changes in CET elasticities compared to the base. Source: Author.

The sectoral growth rates of the GDP do not vary widely when the CET and CES elasticities are changed. The most sensitive sector is the cash crop sector, but even there the maximum magnitude of the change in growth is 2-3 percent. The domestic production decreases the easier it is to substitute its output with imported substitutes, as was to be expected, but increases the easier it is to export the produced goods. The increase in production due to the change of elasticities is somewhat larger than the decrease, and the base results can thus be determined as cautious estimates of economic growth.

Besides production, elasticities used in the consumption function may also change the results gained in the model. The expenditure elasticities of each household group for each commodity used in this study were obtained from econometric estimations made for Tanzania by Delgado and Minot (2000). The sensitivity of the welfare results for these estimations was tested by ranging the value of all the consumption elasticities from 75% up to 175% of the original value with 25 percentage points interval. The sensitiveness of the aggregate welfare measure of equivalent variation (EV) in the base scenario is shown in the table A6. The welfare measures prove to be highly insensitive to the changes in consumption elasticities. Only if the consumption is made less elastic with relation to expenditure, there is a slight change in the annual increase in welfare, but the magnitude of the change is at maximum less than two percent.

% change in elastictity	75	100	125	150	175
Rural poor households	+0.1	5.2	(.)	(.)	(.)
Rural non-poor households	(.)	6.1	(.)	(.)	(.)
Urban poor households	(.)	6.2	(.)	(.)	(.)
Urban non-poor households	(.)	5.9	(.)	(.)	(.)

Table A6: Sensitivity analysis of the change in equivalent variation (EV) with different expenditure elasticities.

On the whole, the model proves to be very robust in the event of possible misspecification of the elasticities. This result increases the credibility of the predictions as they are likely to hold true even when the economy would be slightly different that presented in the model.